INQUIRY INTO THE COLLAPSE OF TEXAS TOWER NO. 4

HEARINGS

BEFORE THE

PREPAREDNESS INVESTIGATING SUBCOMMITTEE

OF THE

COMMITTEE ON ARMED SERVICES

UNITED STATES SENATE

EIGHTY-SEVENTH CONGRESS

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INDEX

LIST OF WITNESSES

INQUIRY INTO THE COLLAPSE OF TEXAS TOWER NO. 4

WEDNESDAY, MAY 3, 1961

U.S. SENATE,
PREPAREDNESS INVESTIGATING SUBCOMMITTEE
OF THE COMMITTEE ON ARMED SERVICES,
Washington, D.C.

The subcommittee (composed of Senators Stennis (chairman), Symington, Bartlett, Jackson, Bridges, Saltonstall, and Smith) met, pursuant to notice, at 10:10 a.m., in room 235, Old Senate Office Building, Senator John Stennis presiding.

Present: Senators Stennis (presiding), Symington, Jackson, Saltonstall, and Smith.

Staff members, Preparedness Investigating Subcommittee: James T. Kendall, chief counsel; Stuart P. French, professional staff member.

Senator STENNIS. Members of the subcommittee, if we may, the subcommittee will please come to order.

Members of the subcommittee, and Mr. Secretary, the chairman has a very brief written statement to make and then a very brief oral addition to that statement. We will then be glad to hear from Dr. Charyk.

FACTS SURROUNDING THE COLLAPSE OF TEXAS TOWER NO. 4

Following an extensive investigation of the facts surrounding the collapse into the Atlantic Ocean of Texas tower No. 4 on January 15 of this year, the Preparedness Investigating Subcommittee, today, begins a series of open hearings on the matter.

What the subcommittee wants to know from sworn testimony of a number of pertinent witnesses is whether Texas tower No. 4 was properly designed, constructed, and kept in repair, and what were the circumstances which may have led to the collapse of the tower by which 28 persons lost their lives.

CONSIDERATION TO SAFEGUARDS FOR TWO REMAINING TEXAS TOWERS IN ATLANTIC

It is important to remember that we still have two Texas towers standing in the Atlantic, both of which have civilian and military crews aboard. We must give consideration to all safeguards which may need to be taken regarding these remaining radar platforms to avert another possible tragedy.

The subcommittee members are aware that the Air Force is concurrently investigating charges which have been preferred against three of its officers and against whom court-martial proceedings may subsequently be instituted.

With this in mind, the members here intend to avoid any discussion of the proper discharge of responsibilities of these officers as military commanders in order to insure against interference with or prejudice to their judicial rights.

It is our purpose today and in subsequent open hearings to confine ourselves to events from 1952 and 1954, when the preliminary studies were made, to January 12 of this year—just 3 days before the tragedy.

In the course of these hearings, the witnesses will include officials of the Air Force; representatives of the architectural firms which participated in the Texas tower program; officials of the Navy's Bureau of Yards and Docks who were involved in the design and construction of Texas tower No. 4; design, construction, architectural and motion-study engineers; a diver inspector, and representatives of the contractor who constructed tower No. 4 and another contractor who built tower No. 2.

Today, we will begin with the testimony of Dr. Joseph V. Charyk, Under Secretary of the Air Force. He will be followed by Mr. E. Ross Anderson, of the architect-engineering firm of Anderson-Nichols Co., Boston, Mass., and Capt. John J. Albers, of the Navy Civil Engineer Corps, who was, at the outset, the officer in charge of construction.

OPENING REMARKS OF THE CHAIRMAN

Now, the Chair would like to add a few additional words for the benefit of the committee members and other interested persons.

After reading over the substance of the testimony as gathered by Mr. French, of our staff, who has done an outstanding job in the opinion of the Chair, and after considering the substance of the testimony that will be presented here, the Chair is of the very firm opinion that instead of interfering with, prejudicing or biasing in any way the judicial rights of the three Air Force officers in the immediate chain of command against whom the Air Force has preferred charges, these hearings will prove a sound, solid background of facts, and a starting point for any court-martial proceeding that might be instituted, and, therefore, should be quite helpful to the justice of their cause. Without a full development of these facts by some forum of this type, I do not see how a court-martial, if one should be instituted, could arrive at a foundation or a solid, sound starting point.

Now, this committee is not passing on the charges against these three gentlemen. We are solely sitting as members of the legislative branch of the Government, charged particularly with policy in connection with our military program, charged expressly by our parent committee with the responsibility of investigating the policies, as well as the appropriations for the general soundness and strength of our vast military program. This inquiry involves the Air Force, which has a very fine record as everyone knows, in doing an outstanding job generally in these perilous times. It cuts across the path of the Navy's Bureau of Yards and Docks, and we know of their fine reputation and generally the good job they do. It also involves private contractors.

We are not here to punish or to condemn. We are not here to praise. We are here to examine the facts, in sworn testimony, and to let the chips fall where they may—for the purposes of implementing the

policies of the legislative branch of the Government and strengthening our defenses and our security.

I want especially to thank the members of the subcommittee. Some time ago we had a full session at which every member of the subcommittee was present, and at which we discussed the desirability of going into this matter. I think it was the unanimous opinion of the subcommittee that we should go into it, as we are now doing. I want to thank each member for being present this morning. All of the members have key assignments and their presence here this morning is a tribute to the subject matter involved and to the entire problem with which we are confronted.

In order that we may move along, I am going to follow the usual committee practice, if it is agreeable to the members of the subcommittee. We will have Dr. Charyk make his statement. We will let counsel question him for a period not exceeding 30 minutes. Then, in the usual order, each Senator will have 10 minutes to ask any special questions he may have, and after we have been around once, we will repeat this process until every Senator has asked all questions that occur to him.

Now, Doctor, in keeping with the committee's strict rule, all witnesses will be sworn. I will ask you to rise, please, and be sworn.

Do you solemnly swear that the testimony you give in this hearing will be the truth, the whole truth, and nothing but the truth, so help you God?

Dr. CHARYK. I do.

Senator STENNIS. Thank you. Doctor, we are very glad indeed to have you here. I have discussed this matter quite briefly this morning with Secretary Charyk, and his attitude about it is very fine. He wants to help us, as does the entire Air Force and Navy, as well.

Doctor, you may proceed.

TESTIMONY OF HON. JOSEPH V. CHARYK, UNDER SECRETARY OF THE AIR FORCE, ACCOMPANIED BY COL. ROBERT P. BALDWIN, CHIEF, AIR DEFENSE DIVISION, DIRECTORATE OF OPERATIONS, HEADQUARTERS, USAF; COL. I. H. IMPSON, CHIEF, ENGINEERING DIVISION, DIRECTORATE OF CIVIL ENGINEERING, HEADQUARTERS, USAF; COL. JOHN E. GILL, DIRECTOR OF FACILITIES SUPPORT, DCS, CIVIL ENGINEERING, HEADQUARTERS AIR DEFENSE COMMAND; MR. MAX GOLDEN, GENERAL COUNSEL, DEPARTMENT OF THE AIR FORCE

Mr. CHARYK. Thank you, Mr. Chairman. I would like to say at the outset that the interest and concern exhibited and the way this committee has approached this hearing is very much appreciated by the Air Force.

I know that the committee is intimately familiar with the many aspects of our air defense system. Texas towers are an integral part of that system. They are, as you know, essentially land-based radar installations moved out to sea, so as to extend the distance from our shores that we are able to detect and destroy hostile aircraft. The need for such increased range is particularly apparent in the case of the northeastern coastal area—our most concentrated industrial pop-

ulation center; and it was in response to this need that the idea of Texas towers was born.

CONCEPT OF FIXED, OFFSHORE RADAR PLATFORMS FIRST OUTLINED AUGUST 1, 1952

The concept of fixed, offshore radar platforms was first outlined in a report dated August 1, 1952, by Lincoln Laboratory of the Massachusetts Institute of Technology. The report found that such structures were possible, if we used shoals that were known to exist 80 to 100 miles off the northeast coast. Accordingly, Lincoln Laboratory recommended consideration of facilities suggested by the original Texas towers—oil drilling platforms in the Gulf of Mexico—to be placed at five selected locations in North Atlantic shallows.

OPERATIONAL ADVANTAGES OF TEXAS TOWERS

The Air Force concurred, with due regard for the significant operational advantages that Texas towers, in common with land-based radar sites, had over both picket ships and early warning aircraft. Unlike the latter, for example, Texas towers could be linked automatically with the SAGE system. Texas towers, moreover, provided a fixed platform, thereby permitting effective radar operations even under adverse weather conditions—a capability that was not possessed by shipborne or airborne radar. In addition, the locations of Texas towers were exactly known and hence their data was considerably more precise than that gathered from mobile stations.

Early in 1954, after the operational requirement for Texas towers was established, the Air Force initiated discussions with the Navy, through its Bureau of Yards and Docks, for the actual implementation of the Texas tower concept. The Navy agreed to act for the Air Force as its design and construction agency. As a first step, the Navy selected the architect-engineering firms of Moran, Proctor, Mueser & Rutledge, of New York City, and Anderson-Nichols, of Boston, to conduct a feasibility study. The Navy also made arrangements with the Woods Hole Oceanographic Institution, Woods Hole, Mass., to furnish to the architect-engineer wind and wave data. The architect-engineer study, which was completed on October 1, 1954, found that the Texas towers were technically feasible and could be built. Work on detailed designs and specifications was begun shortly thereafter by contract between the Navy and the same architect-engineer.

CONTRACT AWARDS ON TEXAS TOWERS NOS. 2, 3, AND 4

A contract for construction of the first Texas tower, No. 2, was let by the Navy late in 1954; and in November 1955, the Navy placed a contract with J. Rich Steers, Inc., New York City, and Morrison-Knudsen, Inc., Boise, Idaho (a joint venture) for the construction of towers Nos. 3 and 4. However, towers Nos. 1 and 5, for which the need was not considered to be as pressing, were not undertaken at that time due to fund limitations and in fact were never built.

I think it might be helpful at this point, Mr. Chairman, if the committee so desires, to view a graphical representation that we have here which indicates the location of the different Texas tower instal-

lations and of the land-based radars, and the coverage of each of these installations. If the committee so desires, we would be happy to discuss it at this point. We have a graphical representation in chart form.

Senator STENNIS. Yes, you may use that, of course.

Mr. CHARYK. I will ask Colonel Baldwin to discuss that.

Senator STENNIS. I think we had better swear the other witnesses now.

SWEARING IN OF OTHER AIR FORCE WITNESSES

Mr. Secretary, will you identify the other Air Force witnesses who expect to testify today? Let the reporter get their names, and we will ask that they be sworn.

I would like to ask each individual to state his name and his affiliation.

Colonel BALDWIN. Colonel Baldwin, Air Defense Division, Directorate of Operations, Headquarters, USAF.

Colonel IMPSON. Colonel Impson, Engineering Division, Directorate of Civil Engineering, Headquarters, U.S. Air Force.

Colonel GILL. Colonel Gill, Director of Facilities Support, DCS, Civil Engineering, Headquarters, Air Defense Command.

Senator STENNIS. All right. Will you stand, please, and be sworn.

Do you solemnly swear that your testimony in this hearing will be the truth, the whole truth, and nothing but the truth, so help you God?

Colonel BALDWIN. I do.

Colonel IMPSON. I do.

Colonel GILL. I do.

Senator STENNIS. I might say, gentlemen, that you may move along rather rapidly, if you wish. We had a very clear summation of the facts of this matter delivered to members of the subcommittee yesterday. We are fairly familiar with the high points of the proof in this case, and have in mind the geographical locations of the towers. We also have documents and illustrations in our notebooks that the staff has thoughtfully supplied, through aid of the Air Force. So we have the general picture before us already.

All right, Colonel.

Colonel BALDWIN. Mr. Chairman, if I might invite your attention—this plotted radar coverage here represents the moderately low altitude coverage provided by the shore-based radars located only along the coastline. Not shown, of course, is the radar coverage to the interior.

Addressing ourselves to the Texas tower desirability, we can see that coverage——

Senator STENNIS. May I ask our photographer friends to be quiet now? You have a proper place, but please remain as quiet as possible.

Colonel BALDWIN. Our radar coverage to seaward, over probable attack routes toward the New England area, is quite short using only the shore-based radar. It was at this point that the concept was developed for the Texas towers. This permitted us to locate offshore SAGE radar which further increased our detection along the probable attack route.

Shown here in yellow is the low altitude coverage for Texas tower 2, Texas tower 3, and shown in orange is the coverage for Texas tower 4.

TEXAS TOWERS NOS. 1 AND 5 NOT NEEDED

Now, at one point we covered the requirement for Texas towers 1 and 5, which would have been located in this area.

As Dr. Charyk mentioned, the requirement was somewhat less because they were farther from the coastline, and they were subsequently dropped.

Our present coverage, as shown today, is indicated by the increase of domestic or shore-based radar—the two locations in this area here, one in eastern Maine, and the one on the coast—the southern tip of Nova Scotia.

This, then, represents the lower altitude radar coverage in the northeast as augmented by the three radar sites.

Senator STENNIS. Why do you offer this proof, Colonel? It will shed some light on the question, I am sure, but why do you offer this particular proof?

Colonel BALDWIN. This is to show the basic requirement for the Texas towers, the desirability of having them.

Senator STENNIS. All right, proceed.

Senator SYMINGTON. Mr. Chairman, I would like to proceed with your question. I do not know of anyone questioning that you might have needed the tower.

Mr. CHARYK. The purpose of this discussion, Senator, was simply to give a graphical illustration of the geographical location of the Texas towers and the corresponding land-based radars.

Senator STENNIS. All right. Thank you very much, Colonel. Let's proceed.

Mr. CHARYK. Construction of Texas tower No. 2 was completed in November 1955; Texas tower No. 3 in May 1957; and Texas tower No. 4 in November 1957. The construction costs of these towers were:

Texas tower No. 2	$12,373,350
Texas tower No. 3	10,060,987
Texas tower No. 4	10,369,166

In addition, equipment and related installation costs of approximately $2,817,000 were incurred for each of the towers. Shown below is a detailed breakdown of the annual operating costs of these towers from fiscal year 1956 to the present.

Annual operating costs of Texas towers

	Texas tower No. 2	Texas tower No. 3	Texas tower No. 4	Total
Fiscal year 1956	$59,150			$59,150
Fiscal year 1957	208,207	57,493		265,700
Fiscal year 1958	258,593	193,553	$139,654	591,800
Fiscal year 1959	339,940	263,152	211,135	814,227
Fiscal year 1960	235,634	274,255	791,512	1,301,401
Fiscal year 1961 (through Apr. 30, 1961)	270,959	348,548	779,169	1,398,676
Total, all years	1,372,483	1,137,001	1,921,470	4,430,954

AIR FORCE ACQUIRES TEXAS TOWER NO. 4

Texas tower No. 4 was turned over to the Air Force by the Navy in November, 1957. To visualize its size and uniqueness, consider the

following dimensions. Texas tower No. 4 stood in 185 feet of water. Each of its three legs were 252 feet long and 12½ feet in diameter, made of 13/16 inch steel plate and braced by three tiers of 24 and 30-inch steel struts. The superstructure was a triangular platform, 66½ feet above sea level, approximately 180 feet on each side. The weight of the entire structure was some 7,000 tons. Its overall height from the ocean floor to the top of the radomes was 345 feet, roughly that of a 30-story building.

I shall now turn briefly to the history of Texas tower No. 4, from when it passed to Air Force control in November 1957 to its tragic collapse in January of this year.

EVENTS LEADING TO COLLAPSE

The first notable event was in the summer of 1958, when the normal motion of the tower increased to the point that in September and October, after Hurricane Daisy, the Navy made an underwater inspection to ascertain the causes. The divers hired by the Navy found some loose bracing connections at the −65-foot level on the shoreward, or A–B, side of the tower. In November, the original construction contractor, J. Rich Steers, was recalled by the Navy to correct these deficiencies.

During the winter of 1958–59, before this work could be completed, the tower underwent 5 storms, with maximum winds of 90 miles per hour and waves of 33 feet observed at the tower.

Upon completion of the repairs in May 1959, there was a noticeable reduction in the motion of the tower. An underwater inspection was made by the Navy at that time, which established that the repairs had been satisfactorily accomplished.

In the course of the winter of 1959–60, the tower was subjected to 4 more storms, with winds to 75 miles per hour and 35-foot waves experienced at the tower.

In the latter part of January 1960, personnel on the tower reported underwater noises and abnormal motion. The Air Force thereupon engaged the services of the Marine Contractors, Inc., the organization which the Navy had previously used for this purpose, to make another underwater investigation. This investigation, concluded in February, disclosed that there were loose connections in the bracing on the A–B plane at the −25-foot and −75-foot levels.

Incidentally, on this model this is the 25-foot plane; this is the −75-foot plane.

Senator STENNIS. If you could have the model of the tower put up higher, and have one of your aides point out the specific places you are talking about, I think the committee, as well as the press, would have a better chance to comprehend this thing.

This is a model to scale of the Texas tower in question; is that right?

Mr. CHARYK. It is a model. I would not say it was to scale.

Senator STENNIS. Well, approximately to scale.

Mr. CHARYK. The significant elements that might be pointed out are, first of all, the A–B plane; which we are talking about, which is the plane in which the major difficulties were experienced; the bracing at the −25-foot level, the −75-foot level, and at the −125-foot level.

Senator STENNIS. All right.

Mr. CHARYK. The investigation, concluded in February, disclosed that there were loose connections in the bracing on the A–B plane at the −25-foot and −75-foot levels.

The original architect-engineering firm—Moran, Proctor, Mueser & Rutledge—was contacted, and they recommended the installation of a system of above-water bracing, which you can see in red on the model. This major project, which involved the expenditure of over $500,000, was completed by J. Rich Steers, Inc., in August; and the tower was certified by the architect-engineer as back to its original strength, capable of withstanding 125-mile-per-hour winds and 35-foot breaking waves.

One month later, on September 12, 1960, Hurricane Donna struck Texas tower No. 4 with winds up to 130 miles per hour and breaking waves in excess of 50 feet. This storm virtually destroyed a maintenance platform, which is indicated just below the platform on the model, 60 feet above the water and severely damaged other portions of the superstructure, as well as the newly installed above-water bracing. The Air Force immediately authorized J. Rich Steers, Inc., to initiate replacement of the maintenance platform, so that an underwater inspection could be made. The platform was essential to the conduct of underwater inspections. The platform was completed by November 1, and underwater inspection began on the same day. Serious damage was discovered, all in the A–B plane, in the upper two tiers of the underwater bracing.

Moran, Proctor, Mueser & Rutledge was again consulted on how best to fix the tower. The plan, developed in a matter of days, was to install cable bracing on the A–B plane from the −25- to the −125-foot level, which would in effect bypass the damaged tiers; and in conjunction therewith to strengthen both the A and B legs. The cost involved was estimated to be from $400,000 to $600,000. Pending the fabrication of these cables, which were designed with a tensile strength of 100,000 pounds per square inch, other underwater repairs were commenced by J. Rich Steers, Inc., in addition to the above-water repairs which that company had started right after Hurricane Donna, without benefit of formal contract.

On January 7, 1961, while underwater workers were readying the A and B legs for installation of the cable bracing, the first of which was scheduled for delivery later in that month, a new break was found in the lowest tier of underwater bracing on the A–B plane. That is the —125-foot level. This break may have been caused by a severe storm in December, which had winds to 90 miles per hour and waves to 40 feet.

On January 12, a meeting was held in the offices of the construction contractor with architect-engineer and Air Force personnel in attendance. It was agreed that, as a result of the new break, a new or modified repair design would be necessary and more extensive work than originally contemplated would be required. It was also decided to complete certain work in progress and then to suspend further repairs until the spring, when weather conditions would be more favorable for underwater work.

On January 14, and 5, the tower was battered by high winds, with gusts up to 85 miles per hour, and heavy seas, with waves as high as

35 feet. Under pressure of the elements, particularly Hurricane Donna and the storms that followed in the winter of 1960–61, and despite all-out efforts to effect repairs, the tower fell into the sea on January 15, 1961, during a storm of gale proportions.

Senator STENNIS. All right. Do you want to add anything to that, Mr. Secretary, before we have questions?

Mr. CHARYK. I do not believe so, Mr. Chairman.

Senator STENNIS. Well, your statement is very clear. Yet, there is one thing I want to get fixed in my mind. The design criteria for this tower was for waves how high and winds how fast? You stated that, I think, at one point. But I do not locate it now.

DESIGN CRITERIA

Mr. CHARYK. Yes. It was to be capable of withstanding 125-mile-per-hour winds with 35-foot breaking waves.

Senator STENNIS. Well, as I have have already said, Mr. Secretary, you are not going to be asked to stay here during all the hearings. Before you leave, these facts that you have related show that the waves were considerably larger than those for which the tower had been designed. Do you want to make a statement as to why you did not withdraw the tower from operation until the repairs could be made? That is going to become a question here. Do you want to pass on that now, or wait until later? I think you ought to have an opportunity to cover that proposition. That is my point.

Mr. CHARYK. I think we can go into that in the course of the questioning.

Senator STENNIS. All right.

Mr. CHARYK. I might simply say at this time, however, that actions to leave the tower had been initiated prior to its failure; the equipment was in the process of being prepared for evacuation, and certain cement, sand, and concrete was being poured into the legs.

Senator STENNIS. All right. If you want to go into that later, that is all right. I thought you ought to have an opportunity now.

Mr. Counsel, will you proceed now.

Mr. KENDALL. Dr. Charyk, in view of the fact that this question is going to come up, will you define for the committee the method of computing the height of a wave—just how it is measured?

Mr. CHARYK. I would like to suggest, Mr. Kendall, that the design criteria might be more appropriately discussed with the architect-engineering people, since it was they who, in consultation with the Navy and on the basis of the Woods Hole and other studies, arrived at the particular design criteria that were used. The Air Force had no responsibility for the design criteria.

WAVES MEASURED FROM TROUGH TO CREST

Mr. KENDALL. On what basis are you using the 35-foot wave in your statement? Is that measured from trough to crest, or from mean sea level?

Mr. CHARYK. From trough to crest.

Mr. KENDALL. At what stage was Texas tower 5 eliminated from the program?

LACK OF FUNDS PRECLUDES CONSTRUCTION OF OTHER TOWERS

Mr. Charyk. It was not possible to fund Texas towers 1 and 5 at the same time as the contract was awarded for 3 and 4, so they were deferred until the following year, and when funding difficulties were encountered in that year, they were further deferred and ultimately a decision was made not to construct them at all in view of the location of the new radar installations in Nova Scotia and Maine.

Senator Stennis. It was a matter of money, then, and the funds available—if I may intervene, Mr. Counsel. That has a bearing at this point? We have been asked these questions by the press and others. We want to clear it up right now. The failure to construct these other towers resulted from the limited money available therefor. Is that correct?

Mr. Charyk. It was in fact, Mr. Chairman, a funding limitation that led to the decision, or that forced the elimination of the construction of towers 1 and 5 at the same time that we proceeded with the others.

Senator Stennis. Well, do you mean that those towers were just stricken out of the program because of lack of money?

Mr. Charyk. It was a question of priorities, and the funds available for the purpose of the Texas tower construction.

Senator Stennis. All right. Counsel, will you yield further on that? What did you do, then, as a substitute? Is that when you strengthened your radar installations on the coastline?

PRIORITY FOR ADDITIONAL TOWERS REDUCED

Mr. Charyk. In subsequent years, it was found possible to proceed with the construction of the new land-based radars in Nova Scotia and in Maine, and it was felt that these new installations would provide adequate coverage so that the priority for additional Texas towers was considerably reduced, and, of course, they were not constructed.

Senator Stennis. Well, this will be my last question on that point. By the same token, why didn't you just abandon Texas tower No. 4 and the other towers, and let the land-based installations serve in their stead?

Mr. Charyk. The Texas towers 2, 3, and 4 provide a coverage out to sea which originally increased the available time for counteraction to the order of 45 minutes. With the increased speed of aircraft, this subsequently became approximately half that value. But at the speeds of present-day jet aircraft, there would still be a matter of 20 or 25 minutes advantage by the use of the installations as shown in the diagram.

Senator Stennis. Well, we can argue about this a long time, Mr. Secretary. But how are you getting along without Texas tower No. 4 now? As I understand it you have no plan to replace it.

Mr. Charyk. We have no plans to replace it, Mr. Chairman, because the time period for reactivation of such an installation would be a matter of several years. With the changing nature of the threat, it is felt that the investment would not be worth it at this time.

NEW RADAR DEVELOPMENT, APS 95

There is also a new development which is pertinent here. We are proceeding to install a new radar aboard the early warning and control aircraft, a radar called the APS 95 which possesses a greatly improved capability over anything we have had before. Also we are installing a new transistorized airborne long-range input system in these aircraft, which will permit the automatic transmission of data to the SAGE system. And so in a sense these aircraft will perform the type of a function that was previously performed by these Texas towers.

So the combination of these facts has led to the decision it would not be worthwhile to resurrect a program of this type at the present time.

NEED FOR THE TOWERS IN THE FUTURE

Senator STENNIS. Well, I am glad that you are capable of going into that, because that is one thing the full committee has already told us informally that they want to know about—the need for these towers in the first place, the continued use of them, and the need for them in the future. We have had a great deal of testimony about the very matters you mentioned, that is, about improvements in the radar systems.

Now, just flatly, you do not propose to replace Texas tower No. 4. What about withdrawing the use of the others? What are your plans on that?

Mr. CHARYK. If the installation of the APS 95 radar and the ALRI equipment on our early warning aircraft proves out as we expect at the present time, we would anticipate that we would abandon the operation of Texas towers 2 and 3 at that time.

Senator STENNIS. All right. Mr. Counsel, do you have further questions?

Mr. KENDALL. One further question. Dr. Charyk, at what stage was tower No. 1 eliminated?

Mr. CHARYK. Substantially the same time period.

Senator STENNIS. What is that?

Mr. CHARYK. Substantially the same time period as I discussed earlier. Namely, there was a deferral to the following year at the time the construction was authorized for towers 3 and 4; funding difficulties and priorities led to the decision for further deferral in the following year. Subsequently it was decided not to proceed with the construction.

Mr. KENDALL. But you took bids for No. 1 at the same time you took bids for towers 3 and 4.

Mr. CHARYK. It was anticipated that reduced costs might be encountered which would permit the construction of 1, 3, and 4 within the funds available. When the bids were received, it was clear that construction would be possible for only two of the towers, and the decision was made to proceed with 3 and 4, which were the highest priority installations.

Mr. KENDALL. Well, how much did the Air Force have in its budget for the construction of those three towers at that time—1, 3, and 4?

Mr. CHARYK. We had a total of $30,300,000. The first tower constructed, No. 2, had consumed approximately $12 million of that, and that left then approximately $18 million for the construction of towers Nos. 3, 4, and 1. When the bids were received, it was clear that only two of them could be constructed within those funds.

Mr. KENDALL. That was primarily a decision on fund limitation rather than operational requirements; is that correct?

Mr. CHARYK. That is correct, at that point.

Mr. KENDALL. That is all I have, Mr. Chairman.

Senator STENNIS. All right, Mr. Counsel.

Senator Saltonstall has shown a fine, judicious attitude, if I might say, about this matter which is of great concern to him. I want to call on him now.

Senator SALTONSTALL. Thank you, Mr. Chairman. I have roughly three questions at this time.

Dr. Charyk, on page 5 of your statement, you said, and I quote—

> while underwater workers were readying the A and B legs for installation of the cable bracing, the first of which was scheduled for delivery later in that month, a new break was found in the lowest tier of underwater bracing on the A–B plane.

You did not state just what that break was.

Mr. CHARYK. It was a break in the joint, in the diagonal attachment at the point indicated.

Senator SALTONSTALL. So that one of your fundamental bracings at the very bottom tier, between −125 and −175, was broken, then?

Mr. CHARYK. This meant that there was now damage in all of the tiers.

BRACING DAMAGE

Senator SALTONSTALL. In all of them? Would you please name all the breaks in bracings once again?

Mr. CHARYK. The above-water bracing, the bracing at the minus 25-foot level, the minus 75, and at the minus 125.

Senator SALTONSTALL. So that there were breaks in four different panels.

Mr. CHARYK. Four different planes, damage in four different planes.

Senator SALTONSTALL. Four different planes. Now, who is responsible for the maintenance of Radar Tower No. 4? Is it the Air Force or the Navy? I bring that out because the Air Force seems to call upon the Navy, and the Navy called upon the contractors. Who is responsible for the maintenance of the tower after the Navy turned it over to the Air Force?

Mr. CHARYK. This was an Air Force responsibility.

Senator SALTONSTALL. It was an Air Force responsibility. So the Air Force turned to the Navy for expert advice on construction and so on.

Mr. CHARYK. In regard to repairs, Senator, the Air Force contracted directly with the same architect-engineering firm, and with the same construction contractor who designed and built the structure to effect the repairs.

Senator SALTONSTALL. Would you repeat that, please?

Mr. CHARYK. The Air Force contracted directly with the same architect-engineering firm and with the same construction firm to effect the repairs.

Senator SALTONSTALL. Well in one place in your statement, do you not say that you turned to the Navy, and that the Navy called in the contractor?

Mr. CHARYK. That was originally, Senator, when the motion that was experienced after the completion of the construction suggested that certain deficiencies might exist. And since the Navy had been the agency responsible for the construction, we contacted the Navy with a view to requesting an underwater inspection to in fact ascertain whether certain deficiencies existed. When the underwater inspection was conducted, it did, in fact, confirm that certain deficiencies existed, and the Navy then took action to effect an elimination of these deficiencies.

Senator SALTONSTALL. Now, whose responsibility was it—the Navy or the Air Force—to determine whether this tower was safe or not?

SAFETY OF TOWER WAS RESPONSIBILITY OF THE NAVY

Mr. CHARYK. The Navy, as the construction agency for the Air Force, had the responsibility for acceptance of the original design and construction.

Senator SALTONSTALL. And then subsequent to that time, the Air Force took full responsibility. Did the Air Force have the responsibility for determining that it was safe after the Navy turned it over to the Air Force?

SAFETY OF TOWER AN AIR FORCE RESPONSIBILITY AFTER ACCEPTANCE FROM NAVY

Mr. CHARYK. The Air Force had the responsibility for the subsequent maintenance.

Senator SALTONSTALL. Do you consider these breaks a matter of maintenance rather than original deficiencies?

Mr. CHARYK. We treated them as necessary repairs. Whether these difficulties were related to original design deficiencies is very difficult to say. But we treated them as maintenance problems.

Senator SALTONSTALL. Thank you, Mr. Chairman. That is all at this time.

Senator STENNIS. Thank you, Senator Saltonstall.

Senator Symington?

Senator SYMINGTON. Mr. Secretary, as usual your statement is very clear. I would like to ask one or two questions here.

I did not understand about the participation of the Navy in this matter. On page 2 you say, "The Navy agreed to act for the Air Force as its design and construction agency." You do not say at any point that the Air Force, in any form of formal or informal action, takes responsibility for the tower?

Mr. CHARYK. The final acceptance by the Air Force was in November of 1957.

Senator SYMINGTON. How did you accept it?

Mr. CHARYK. The acceptance was after the elimination of certain deficiencies within the platform itself. The Air Force was not in-

volved in a determination of the adequacy of either the design or the construction.

Senator SYMINGTON. Who found out these deficiencies?

Mr. CHARYK. Insofar as the deficiencies on the platform are concerned, these were of a very minor nature. The resident officer in charge listed some 14 or 15 minor items, such exterior painting, tags for valves, replacement of windows, and so on.

Senator SYMINGTON. Is there any paper between the Air Force and the Navy as to who is responsible for the tower?

Mr. CHARYK. Insofar as the design and the construction is concerned, this is clearly the responsibility of the agency charged with the construction.

Senator SYMINGTON. Which agency is——

Mr. CHARYK. The Navy.

Senator SYMINGTON. But now you say the Air Force took it over. When it took it over, did they agree to maintain it?

Mr. CHARYK. This is the normal procedure.

Senator SYMINGTON. Well, I am not talking about the normal procedure. It is not the normal procedure for a tower to fall on its face in the water. What I want to know is, at any time did the Air Force say, "Now, this is our responsibility from here out."

Mr. CHARYK. This was implied in the final acceptance. We accepted the tower under the understanding that it was designed and constructed to withstand the type of conditions that could be anticipated to be encountered.

Senator SYMINGTON. Did you agree to take over the responsibility for its maintenance?

Mr. CHARYK. Yes.

Senator SYMINGTON. Now, you say the first notable event was in the summer of 1958. The Navy made an underwater inspection to ascertain the causes. Why did not the Air Force make the underwater inspection?

Mr. CHARYK. The observations of the tower's behavior suggested a possible construction or design deficiency. We therefore felt that it was appropriate to ask the Navy to make a check to determine whether in fact such a deficiency existed.

Senator SYMINGTON. Well, why did you not make the check yourself?

Mr. CHARYK. The Navy, as the construction agency, had the responsibility to insure the structural integrity of the design. And we therefore felt it appropriate to have them make the check.

Senator SYMINGTON. And if that were true, the Navy never lost that responsibility, did they?

Mr. CHARYK. Well, this is within the first year after the completion of the contract, and we felt that this was within the time period in which this could be considered a part of the original job.

Senator SYMINGTON. Well, supposing it happened in the second year, would that not be considered part of the original job?

Mr. CHARYK. It could have been done either way at that point. We could have gone back to the Navy on subsequent occasions and asked them for a further check.

Senator SYMINGTON. Well, I trust you realize how cloudy your testimony is as to who is responsible for the maintenance of this tower.

AIR FORCE RESPONSIBLE FOR MAINTENANCE OF TOWER

Mr. CHARYK. I would say that the Air Force is responsible for the maintenance of the tower. However, after the tower was originally turned over to the Air Force, observations indicated that there might in fact be certain deficiencies. So we felt it appropriate, on these occasions, to go back to the Navy and ask them to ascertain once more whether they were in fact satisfied with the adequacy of the construction and the design.

Senator SYMINGTON. Apparently as a result of what they found, they were not satisfied, is that correct?

Mr. CHARYK. They were not satisfied. And they made certain changes, recommended certain additional changes which were effected, and then certified that the tower was back to original design specifications.

Senator SYMINGTON. When did they do that?

Mr. CHARYK. That was, I believe, in May of 1959.

Senator SYMINGTON. That is not in your original statement, but you are confident that is correct?

Mr. CHARYK. Yes, sir.

Senator SYMINGTON. Now, you had some more storms in the winter of 1959–1960, and at this point you, yourself, hired somebody, is that correct?

Mr. CHARYK. That is correct. We hired the services of the same organization which had undertaken the inspection for the Navy.

Senator SYMINGTON. So in 1958, you went through the Navy to get the repairs, and in 1959–1960 you went to the same people direct to get the repairs, is that right?

Mr. CHARYK. That is right.

Senator SYMINGTON. At that time did you discuss the matter with the Navy?

Mr. CHARYK. They were advised, but there was no formal approach to them.

Senator SYMINGTON. And the firm of Moran, Proctor, Mueser & Rutledge was contacted, and it recommended the installation of above-water bracing. Where did you get their name?

Mr. CHARYK. This was the same architect-engineer that had been involved in the original design for the Navy.

Senator SYMINGTON. So in both cases, even though you, yourself, went direct, you went back to the same people that the Navy had originally employed, to do the job, is that correct?

Mr. CHARYK. That is correct.

Senator SYMINGTON. And then at some point presumably they said, "Now it is fixed."

TOWER MEETS ORIGINAL DESIGN SPECIFICATIONS AFTER REPAIRS

Mr. CHARYK. The contractor installed the above-water bracing, made certain other modifications, and then again the architect-engineer indicated that it was back to original design specifications. This was in August, early August of 1960.

Senator SYMINGTON. In other words, they told you at this point that the tower was all right; is that correct?

Mr. CHARYK. That is correct.

Senator SYMINGTON. These same firms that originally built it and designed it?

Mr. CHARYK. That is correct.

Senator SYMINGTON. And then more trouble developed. When did the next trouble become evident?

Mr. CHARYK. The next significant event was Hurricane Donna, which was on the 12th of September 1960. As a result of the hurricane, it was apparent that significant repair work would have to be accomplished. The maintenance platform had been completely destroyed, and extensive damage was observed in the above-water bracing.

Senator SYMINGTON. Now, whom did you consult, if anybody, at that time?

Mr. CHARYK. We went back to the same architect-engineering and construction people that we had dealt with earlier.

Senator SYMINGTON. So that at no time has the Air Force worked with anybody except the people who originally designed it and built it in accordance with your request to the Navy; is that correct?

Mr. CHARYK. That is correct.

Senator SYMINGTON. Did they certify to you that it was all right in 1960?

Mr. CHARYK. Yes, in August of 1960.

Senator SYMINGTON. Did you get it in writing?

Mr. CHARYK. We have a confirmatory message to that effect.

Senator SYMINTON. What do you mean by a confirmatory message?

Mr. CHARYK. A letter which was sent to Otis Air Force Base, dated November 16, 1960, confirming the integrity of the structural design as of August 10, 1960, in accordance with the original design criteria.

Sentaor SYMINGTON. What was the date?

Mr. CHARYK. The confirming message was dated November 16, 1960.

Senator SYMINGTON. And who signed it?

Mr. CHARYK. It was signed by Mr. Kuss, of Moran, Proctor, Mueser & Rutledge.

Senator SYMINGTON. And where do they come from?

Mr. CHARYK. He was an engineer for the architect-engineering firm.

Senator SYMINGTON. Where is that firm located?

Mr. CHARYK. It is located in New York City.

Senator SYMINGTON. Was that the original firm, the architect firm that the Navy had on the job?

Mr. CHARYK. That was the original firm. In summary, the message states that the design analyses result in the conclusion that Texas tower No. 4 structure, after completion of installation of the new braces, was safe to resist simultaneously 125-mile-an-hour winds, 35-foot high breaking waves, or a 60-foot high nonbreaking wave.

Senator SYMINGTON. Well, now, was everything done that they said should be done?

Mr. CHARYK. Yes, sir.

Senator SYMINGTON. And in spite of that, it fell into the water?

Senator SALTONSTALL. What was that question, please?

Senator STENNIS. Repeat that question.

Senator SYMINGTON. Was everything done that they said should be done?

Mr. CHARYK. All of the repair work as recommended was accomplished.

Senator SYMINGTON. And in spite of that, in a couple of months, it fell into the water; is that right?

Mr. CHARYK. I think it is fair to state, Senator, that Hurricane Donna exceeded the original design criteria.

Senator SYMINGTON. Who set the original specifications?

PREPARATION OF ORIGINAL SPECIFICATIONS

Mr. CHARYK. The original specifications were prepared by the architect-engineering firm, and by the Navy.

Senator SYMINGTON. I have no further questions, Mr. Chairman.

Senator STENNIS. Thank you, Senator.

Senator Jackson?

BASIC ISSUES INVOLVED IN COLLAPSE

Senator JACKSON. Mr. Chairman, it seems to me that this thing boils down to two basic issues. One is whether due care and prudence was exercised in the design, engineering, and construction. Then, after the tower was built, was due care and prudence exercised by those in authority charged with the responsibility of maintaining it. Perhaps my assumptions are wrong, but being what they are, I would like to ask a couple of questions.

Did the Air Force agree, from an engineering technical standpoint, with the findings of the Navy's architect design engineer?

Mr. CHARYK. It was not appropriate for the Air Force to make a determination as to the design specifications.

Senator JACKSON. So that when the Navy acted for the Air Force as its design and construction agency, I take it that you did not exercise any veto or supervision over the technical design and details worked out by the Navy with its contractor.

Mr. CHARYK. We do not.

Senator JACKSON. Now, the other question I would like to ask is this: Do you know whether the design for the other towers that were built were similar to this one? Were they all of the same design? If not, why not?

Mr. CHARYK. The designs were different because of the different conditions which existed at the location of the other two towers; namely, the actual wave and wind conditions, and the depth of the shoals.

Senator JACKSON. Well, the others are still up and apparently in pretty good condition. Did they have, in your judgment, better engineering design incorporated into them than this tower No. 4?

Mr. CHARYK. The same individuals were involved, so that I would be led to the conclusion that designs were probably comparable.

Senator JACKSON. The same firm did the design for all of them?

Mr. CHARYK. That is correct.

Senator JACKSON. From an engineering standpoint, considering the area in which you had to work, both with the elements and the sea floor, was this particular site similar to the others?

Mr. CHARYK. No. The Texas tower No. 4 was by far the most difficult condition, in terms of the water depth in particular.

Senator JACKSON. Were the Navy and the Air Force cognizant of the difficult design and engineering problems presented by this assignment?

Mr. CHARYK. The data, I presume, was completely assessed by the Navy and led to their determination that adequate design could be effected.

TWO PROXIMATE CAUSES OF TRAGEDY

Senator JACKSON. It seems to me that the proximate causes of this tragedy are two. One is the design and construction, and the other, the failure, at a subsequent time, to get the people off the tower. I am trying to pinpoint now the genesis of this business; namely, whether the engineering design work that went into it was prudent and sound. Was there a decision made by the Air Force after these first incidents occurred, that perhaps the tower was not designed properly, or constructed properly? Of course, the construction follows the design, and if the design is faulty, the construction is not going to be much better, if you are dealing with the basic engineering problem.

Mr. CHARYK. Well, as I indicated in my statement, we did have some concern as to the adequacy of the design and/or construction, so we went back to the Navy and asked for an inspection and a reaffirmation. Their inspection indicated certain deficiencies which were corrected, and subsequently they reaffirmed the adequacy.

Senator JACKSON. Well, in your judgment, or if not in yours, have you been advised that this tower could have been designed and constructed so that it would not have collapsed? Do you have any evidence of that?

Mr. CHARYK. I would think that the Navy might more properly respond to that question, Senator, because the Air Force, as I indicated earlier, has no responsibility for the design.

Senator JACKSON. Well, now, my question is, after you took this over, and when you had the responsibility of maintaining it, did your people—I do not mean you personally, because I know that you did not necessarily have anything to do with it during this period of time—did the Air Force come to a conclusion that this tower was not properly designed after discovering the trouble that they were experiencing?

Mr. CHARYK. Well, the Air Force certainly had some concern in that regard, because of the behavior that was observed. And it was for this reason that it went out in January of 1960 and contracted directly for another underwater inspection. And at that time, the recommendation was made by the architect-engineer because of the difficulties that were noticed in the bracing, that the best solution would be to install the above-water bracing. So we accepted this recommendation.

Senator JACKSON. Well, this is repair work. This is merely trying to hold on to what you have. I am just asking as a layman, would you be able to say as of today whether this, in your judgment, or if not in your judgment in advice that you received, whether this tower was properly designed to meet the known elements that it had to face, knowing where it was being placed? And then, was it properly constructed in the first place? That is my question.

Mr. CHARYK. I would personally have no real basis for judgment as to the adequacy of the original design.

Senator JACKSON. All right. That is fair enough. Has the Air Force ever been advised, or have you received advice from those who are in a position to know, from a professional standpoint, whether or not this tower was properly designed?

Mr. CHARYK. I have personally seen no indication that would suggest otherwise.

Senator JACKSON. So that, in other words, if you were out to do this again, you would not have a better design than the one you had, and therefore, no matter what you did, it would collapse. That is apparently——

Mr. CHARYK. No; I would think that the architect-engineer might in fact make certain design modifications if he were to do the job again.

Senator Jackson. Surely there must be—I do not want to be unfair, but is it not quite clear now that there was a design failure in this thing, then construction followed, and collapse—surely it could have been designed differently and would have stood up. Now, if I am wrong, then I want to——

ADEQUACY OF DESIGN CRITERIA

Mr. CHARYK. From a personal point of view, I would have some concern as to the adequacy of the original design. But as I say, there are some difficult factors involved here so that in order to have a firm position one would have to undertake a complete analysis of the situation, which of course I have not done.

Senator JACKSON. Well, we will go into the question later whether prudence was exercised at the time the decision was made to go ahead with this design. That is the Navy's responsibility, and I will direct my questions in more detail, Mr. Chairman, at that time.

Senator STENNIS. All right, Senator.

Mr. CHARYK. I would like to just reiterate one other point, Senator, namely, Hurricane Donna which was, I believe, largely instrumental in the final failure did exceed the original design criteria.

Senator JACKSON. But it was in trouble prior to Donna.

Mr. CHARYK. There were difficulties experienced prior to that.

Senator JACKSON. And from what I read from your statement, it is clear to me that this tower could have collapsed with something short of Donna.

Senator STENNIS. Just 1 minute, if you can, Senator. Are you through?

Senator JACKSON. Yes, I am through.

Senator STENNIS. Following up Senator Jackson's questions, Mr. Secretary, this is the way it looks here to a layman. You have this tower designed to withstand certain forces of winds and waves. Now, did the wind ever equal or exceed the design criteria?

Mr. CHARYK. I think in the case of Hurricane Donna, they exceeded the design criteria.

Senator STENNIS. All right. Up to Hurricane Donna the velocity of the wind had not reached the design criteria. Still you had all this trouble. The waves had not exceeded the design maximum, up until then, had they?

Mr. CHARYK. I believe that is correct.

Senator JACKSON. That was my point, Mr. Chairman.

Senator STENNIS. Yes, that is right. Still in all, as Senator Jackson said, you had all this trouble with the tower. It was giving way. It was weakening and constantly needing repairs and reinforcement. How do you explain the continued operation of this tower up until Hurricane Donna in view of those facts? I am not including Hurricane Donna in my question.

Mr. CHARYK. Well, I would say——

Senator STENNIS. Pardon me for just a moment. For the information of the committee, subject to the approval of the committee, the Chair hopes that we can run until about 12:30 and reconvene then at 2:30.

Senator JACKSON. Mr. Chairman, I have a resolution on the floor. I must leave.

Senator STENNIS. We have witnesses summoned here, some from a considerable distance, and we want to accommodate them in every way we can and finish with those today.

Senator JACKSON. Mr. Chairman, I want to say I have the highest regard for Dr. Charyk. I do not want him to think that any of my questions were intended to reflect on his sound professional ability. They were not related to that. I am just trying to get the facts in connection with this inquiry.

Senator STENNIS. Surely. We appreciate that. All right, Doctor, pardon that interruption.

CONTRIBUTING FACTORS TOWARD WEAKENING

Mr. CHARYK. Well, I would say, I think one of the contributing factors was revealed in the original underwater inspection when it was noted that the Dardelet bolts which had been used to attach the collars were not operating properly, and the collars were actually moving up and down the legs. This, in turn, caused abnormal wear on the pins in the bracing, so that over the period of time in which this condition existed the pin clearance had been greatly increased. This introduced then a flexibility into the system which had to be corrected in some other fashion, and ultimately we went to the above-water bracing as an attempt to cure that difficulty.

Senator STENNIS. I was not questioning anything you did, Doctor, I was comparing the situation. It seems to me the proof so far shows that, in view of what was happening, even though the waves and the wind had not exceeded the design criteria this tower was not going to stand. Very serious defects had repeatedly developed. Yet, the operation of the tower was continued until Hurricane Donna, assuming that Hurricane Donna was the last one.

REPAIRS MADE IN 1960 DEEMED ADEQUATE

Mr. CHARYK. Well, the Air Force had concern as to the adequacy. It was for this reason that in January of 1960 it again asked for an underwater inspection and recommendations as to what types of action would correct the difficulty. The recommendation was made to install the above water bracing, make certain other repairs, and at the completion of this work, it was again certified to the Air Force that the tower was back to the original values.

Senator STENNIS. But it already had been proven that the original criteria was not sufficient. That is the question that bothers me. You continued the operation of the tower in the face of the fact that the criteria was inadequate. What is your answer to that?

Mr. CHARYK. I would say that there was a new element introduced. That mainly, because of the existence over a period of time of this original deficiency, a certain deterioration in the structural integrity had been experienced, and it was our understanding that the construction of the above-water bracing would correct this and bring it back to the original design strength. In other words, I would think that it would be fair to say that our interpretation was, that because of the existence of this original defect, that certain damage had been introduced into the structure which then brought its capability below the original specifications, and then, we were reassured that with the repairs and with the above-water bracing, that it was now restored to its original value.

Senator STENNIS. Well, that is my point. I want to avoid using hindsight because it does not sound good to me to hear someone else use it. You are not using it. My specific point is that the experience with this particular tower seems to have clearly shown that the criteria was not adequate to begin with. That is leaving Hurricane Donna out of consideration. The wear and tear on the tower had accentuated the deficiency in its stability. Still it seems that those in authority contented themselves with just trying to get the tower up to the original conception of what stresses would be encountered, and that they made no effort to go beyond that. This continued until finally Hurricane Donna came, and it presented added stress and force that the already inadequate tower could not withstand, as I see it.

Mr. CHARYK. I think it would be fair to say that the Air Force assumed that there was a degradation in the capability as a result of the original defect, and therefore, during this period, the tower was probably not in a condition to meet the original design specifications. With the completion of the recommended repairs in early 1960, we had no reason to doubt that the tower was now back to the original specifications which probably were never initially completely realized because of the original defect and the subsequent damage that was realized from this original defect.

NO CONSIDERATION GIVEN FOR EXCEEDING ORIGINAL STRENGTH REQUIREMENTS

Senator STENNIS. Well, even if the tower had been constructed in the beginning to measure up to the design criteria, it certainly appears that this had proved inadequate by the time of Hurricane Donna. Do you not agree with that? You were trying to strengthen it. My complaint is that, even in the light of your experience, you did not go beyond the original concept of what was necessary.

Mr. CHARYK. Actually we were reassured on August 10, 1960, that with the repairs that had been effected, this tower was now back to design specifications, and Donna arrived approximately 1 month later.

Senator STENNIS. Did you ever ask the Navy to go beyond its original criteria in requirements of strength?

Mr. CHARYK. We left the responsibility for the determination of the proper design specifications with them.

Senator STENNIS. It seems you assumed, then, in spite of the actual experience, that the original criteria was adequate.

Mr. CHARYK. That is correct.

Senator STENNIS. All right.

Senator SALTONSTALL. I would like to ask this question, in line with what the Chairman has just said. You assumed that the tower was safe when you put on this additional bracing above the waterline that is shown there on the model in red. Now, was there ever any determination made of the difficulties that might arise from the additional resistance to the waves by those bracings?

Mr. CHARYK. I presume that this was completely considered by the architect-engineer.

Senator SALTONSTALL. As you see, looking at the model, there is no bracing anywhere near the waterline until you install this additional bracing above the waterline, which would make for additional wave resistance.

Mr. CHARYK. This would certainly introduce additional forces on the structure. And I would assume that this was properly considered by the architect-engineer.

Senator SALTONSTALL. You assume. You have no specific knowledge or specific certification?

Mr. CHARYK. It was indicated in the communications to us this effect had been considered.

Senator SALTONSTALL. Who made that statement?

Mr. CHARYK. The architect-engineer.

Senator SALTONSTALL. And it was not the Navy, then, who was the architect-engineer?

Mr. CHARYK. At this point, the Air Force was contracting directly with the architect-engineer.

Senator SALTONSTALL. So that the Navy did not have anything to do with installing these additional braces above the waterline.

Mr. CHARYK. They did not.

Senator SALTONSTALL. That was done directly by the Air Force, with the contractor?

Mr. CHARYK. That is correct.

Senator SALTONSTALL. And the contractor certified that the original design was not injured by those additional bracings?

Mr. CHARYK. The architect-engineer indicated that this had been properly considered by him.

Senator SALTONSTALL. Thank you Mr. Chairman.

Mr. Chairman, I am trying to call attention to the fact that now the Air Force is dealing directly with the contractor with relation to the above-water bracing, which had so much to do with additional resistance from waves.

Senator STENNIS. Thank you, Senator.

Senator Symington?

Counsel, do you have further questions at this point?

Mr. KENDALL. Dr. Charyk, do you know whether or not any contract has been awarded for the inspection of towers 2 and 3 from a structural integrity standpoint?

CONTRACTS FOR INSPECTION OF TEXAS TOWERS NOS. 2 AND 3

Mr. CHARYK. Yes. The 1st Naval District has contracted with the Hinchman Corp. for inspection of the corrosion control system on each of the towers, 2 and 3. They have also awarded a contract to Moran, Proctor, Mueser & Rutledge, and as a subcontract to them, the New York Testing Laboratory is undertaking an examination of the high stress areas above and below the water level, using magnaflux and other techniques. This above-water inspection, I believe, has been completed, and the below-water inspection is to be accomplished in the next month or so.

It is my understanding also that no faults or weaknesses have been revealed in the inspections that have been conducted to date.

The 1st Naval District has also awarded a contract to Moran, Proctor, Mueser & Rutledge to reexamine and to recalculate the structural strength of these towers, based upon a reexamination of the wind and the wave phenomena in light of current experience.

Mr. KENDALL. The Moran, Proctor firm, were the original design engineers; were they not?

Mr. CHARYK. They were the original firm involved.

Mr. KENDALL. So the Navy selected the original design engineers to make this computation of the safety of the remaining towers?

Mr. CHARYK. That is correct.

Mr. KENDALL. Do you think that is good judgment, Doctor?

Mr. CHARYK. I would personally feel that it would be better to get an independent judgment in the matter.

Mr. KENDALL. Thank you.

Senator STENNIS. What was your question on that?

Mr. KENDALL. I asked him if he thought it was good judgment to select the original design engineers to make the safety inspection of the remaining two towers.

Senator STENNIS. I see. All right.

Senator Symington?

REASON FOR SELECTION OF ORIGINAL ARCHITECT ENGINEERS TO MAKE INSPECTIONS

Senator SYMINGTON. Well, pursuing that, I ask this question very frankly:

First, let the record show I have never discussed this matter with any military or civilian member of any of the services. But by going back to the people who built it, designed it and built it, in effect you are recognizing that there were not many people in the Air Force who understood the subject; were you not?

Mr. CHARYK. Well, I think at the time of our request for inspection, time was of the essence. In other words, if repairs had to be effected, which it was pretty clear would be the case, prompt action would have to be taken to effect this work before the hurricane season.

As a matter of fact, working directly with the people who had been intimately involved, it took until August to effect the repairs, and Donna arrived a month later. So I feel that in retrospect, had we gone to a complete new organization at that time, it would not have been possible to effect a redesign and repairs prior to the hurricane season in 1960.

Senator SYMINGTON. The first time, through the Navy, you went to the people who were apparently responsible for the faulty design and/or the faulty construction.

The second time you went on your own, based on your statement.

When you went on your own, did you discuss it with the Navy at that time, when you realized for the second time you were in trouble?

Mr. CHARYK. It is my understanding that the Navy was informed that we were dealing with the architect-engineer, and with the construction firm, in regard to new inspection and repair work.

Senator SYMINGTON. Did they suggest any different procedure?

Mr. CHARYK. I understand that they offered their services at the time that they were informed, but we had already placed a contract with the architect-engineer.

Senator SYMINGTON. But when they offered their services, the previous time, when you worked with them the previous time, they had gone to the people you went to direct this time; did they not?

Mr. CHARYK. Yes.

Senator SYMINGTON. So then it would seem to me that you did what they would have done. Did they suggest any different course of action than the one you took?

Mr. CHARYK. No, they did not.

Senator SYMINGTON. Did they suggest a new designer or a new constructor?

Mr. CHARYK. They did not.

Senator SYMINGTON. Now, I think when I was questioning before, we got up through November—you read a statement where the architect-engineer certified that everything was all right in a letter dated August 10, 1960.

Then you began to have troubles, based on page 5 of your statement. In January 1961 a meeting was held in the offices of the construction contractor with the architect-engineer and Air Force personnel.

Was that the original designer and the original builder?

Mr. CHARYK. The original designer and original builder, yes.

Senator SYMINGTON. Were there any Navy personnel at that meeting?

Mr. CHARYK. I do not believe so.

Senator SYMINGTON. Why not?

Mr. CHARYK. They had not been involved since our original contract with the architect-engineer firm in January of 1960. So there was no particular reason to invite them to this meeting.

WARNING BY ARCHITECT-ENGINEER OF CONDITION OF TOWER

Senator SYMINGTON. Now, at that time, apparently, you had a new break, new things had to be done because this design and construction apparently was faulty, one way or the other, or both.

At that time did the architect or the builder warn you that the tower might fall on its face?

Mr. CHARYK. The architect-engineer indicated that the tower was in serious condition.

Senator SYMINGTON. And what steps were taken, if any, by the Air Force?

Senator STENNIS. Pardon me just a moment.

LIMITATION ON SCOPE OF HEARINGS

For the record, I would like to say that the committee decided at a meeting some 3 weeks ago that we would go as far as this conference of January 12, obtain a summary of what the conditions were then, and use every effort to make that a cutoff date. We agreed that we would not go into what developed after January 12 at this hearing. From then on there is involved the question of command responsibility, which will be the subject of a hearing in another forum. Senator Symington was at that meeting, but was not there when that particular point was agreed upon.

Senator SYMINGTON. That is right, Mr. Chairman. I did not know about that. I regret that I did not.

Senator STENNIS. Well, no harm has been done, if you just withdraw the question beyond January 12.

Senator SYMINGTON. I will withdraw the question.

Mr. Secretary, I congratulate you on your clear testimony. It is obvious to me that despite the unilateral criticism of the Air Force in all press stories that I ever read that the responsibility for designing and building this tower is at least as much the responsibility of the Navy, and that also the people who designed it and/or built it apparently did not know how to design and/or build it right, because they had, time after time, an opportunity to correct the design which appears to be basically faulty.

As to what happened after this date, I understand now that it would not be advisable to go further. I simply point out to you again that this, once more, is a result of the separate empires, is a complete practical and clear illustration of what will be avoided if you had a normal organization over there with responsibility located with authority and authority commensurate with responsibility.

Senator STENNIS. All right. Thank you, Senator.

Senator Saltonstall, do you have further questions of the Secretary?

Senator SALTONSTALL. Mr. Chairman, on page 4 of the brief summation of the issues, there is a reference to the meeting of January 12. The Secretary has testified that at that meeting it was determined that the tower was in serious condition. Now, the summation states that at that meeting a statement was made that the tower was 55 percent as strong as it would be if it were intact. Would that be before any repairs were made, or were to be made, or would that be after the repairs were completed? Do you know?

Mr. CHARYK. I cannot attest to the 55 percent figure.

Senator STENNIS. Thank you. Counsel, do you have anything further?

Mr. KENDALL. No, sir.

Senator STENNIS. Well, Mr. Secretary, we thank you very much. From what I know about this case, it seems that the Air Force has outlined the high points of its participation in this matter. We are going to endeavor, as I have already said, to make January 12 the cutoff date. Now, Mr. Secretary, you will be available should we need you this afternoon or tomorrow, is that correct?

Mr. CHARYK. I will be available if the committee so desires.

Senator STENNIS. We want to thank you again for being here. Of course, you do not have to go. If you wish, you may.

Mr. CHARYK. Thank you.

Senator STENNIS. Members of the committee, our next witness is Mr. Anderson. He has a brief statement which is now being supplied by Mr. Anderson.

Mr. Anderson, will you be sworn, please.

Do you solemnly swear that your testimony here before this subcommittee in this hearing will be the truth, the whole truth, and nothing but the truth, so help you God?

Mr. ANDERSON. I do.

Senator STENNIS. All right, gentlemen.

Now, those who wish to retire may do so, of course, but please do so quietly and rapidly. Otherwise, please take your seats.

Mr. Anderson, you have a prepared statement, I believe.

Before you make that statement, counsel has some questions that will lead up to this and shed further light on your statement.

Counsel, may we ask you to be as brief with your preliminary questions as you can?

TESTIMONY OF E. ROSS ANDERSON, PRESIDENT, ANDERSON-NICHOLS CO., BOSTON, MASS., ACCOMPANIED BY JOHN MINNICH, CHIEF STRUCTURAL ENGINEER; MARTIN G. ROLLAND, CHIEF MECHANICAL ENGINEER; AND JOHN K. HOLBROOK, COUNSEL

Mr. KENDALL. Mr. Anderson, I believe you are appearing here as a result of a subpoena issued by the committee, is that correct?

Mr. ANDERSON. That is correct, sir.

Mr. KENDALL. What was your connection generally with the Texas tower program?

Mr. ANDERSON. I believe this is covered in my statement here.

Mr. KENDALL. I mean to have you identify the business you are in and the type of organization you have.

Mr. ANDERSON. We are an architectural engineering firm.

Mr. KENDALL. Where are you located?

Mr. ANDERSON. Boston, Mass.

Mr. KENDALL. How large an organization do you have?

Mr. ANDERSON. It is an organization of just under 300, between 250 and 300.

Mr. KENDALL. What is your connection with it?

Mr. ANDERSON. I am president of that organization.

Mr. KENDALL. I believe that you have a prepared statement. Will you proceed with that, sir?

Mr. ANDERSON. Do you wish me to read it?

Mr. KENDALL. Yes, sir.

Mr. ANDERSON. On March 23, 1954, we received a telephone call from Mr. Robert Seddon of the 1st Naval District in which he stated that a project for the Air Force was being considered, which would be of some magnitude, tentatively estimated at $20 million. Mr. Seddon requested that we call on him for further discussion. Mr. Vincent Cates of our organization took this call.

Senator SYMINGTON. Will you identify who Mr. Seddon is.

Mr. ANDERSON. Mr. Seddon is a civilian employee at the 1st Naval District, and as to his exact title, I am not sure.

Senator SYMINGTON. Did you know him before?

Mr. ANDERSON. Yes, we did.

Senator SYMINGTON. What was his position? It seems to be a little vague in your statement as to just what he did.

Mr. ANDERSON. I cannot give his exact title. To our knowledge, he was the top civilian in that organzation.

Senator SYMINGTON. Thank you.

Mr. ANDERSON. After receiving the call mentioned in paragraph 1, Mr. Cates immediately called on Mr. Seddon at the 1st Naval District, this being the same date as mentioned in paragraph 1. During this discussion Mr. Seddon stated that this would be a top secret project for the Air Force and would be handled under the direction of the 1st Naval District. He further stated that the project was conceived by the Lincoln Laboratory. He went on to state that the foundations which would be involved would be a prime factor in the project and suggested that we give serious consideration to this element of the project. Mr. Seddon briefly outlined the problems involved, together with an outline of general criteria pertaining to the towers, and advised that they would be in touch with other firms and was purely putting us on notice that we would be one of those considered for the project.

On Mr. Cate's return to the office a discussion was held at which it was determined that we should obtain assistance on foundation work. Following this, Mr. Anderson contacted Mr. Proctor of Moran, Proctor, Mueser & Rutledge, stating that there was to be a very important project at the 1st Naval District and asking Mr. Proctor to meet with him in Boston the following day to discuss joining forces.

Senator SYMINGTON. What was Mr. Proctor's position with Moran, Proctor, Mueser & Rutledge?

Mr. ANDERSON. I believe at that time, sir, that Mr. Proctor was a senior partner or president. I do not recall whether it was a partnership or a corporation at this time.

Senator SYMINGTON. Thank you.

Mr. ANDERSON. Mr. Proctor came to Boston the following day at which conference it was agreed that Moran, Proctor, Mueser & Rutledge would handle the submarine foundation work incident to the project and Anderson-Nichols would do the balance.

Mr. KENDALL. Mr. Anderson, will you explain a little more in detail as to exactly what you mean by the submarine foundation work.

SUBMARINE FOUNDATION DEFINED

Mr. ANDERSON. I am referring to all design work necessary from the sea bottom and below.

Mr. KENDALL. It was originally contemplated that would be Moran and Proctor's responsibility?

Mr. ANDERSON. That is correct.

Mr. KENDALL. And your firm's responsibility then, I take it, was originally contemplated to be everything from the sea bottom on up to the top of the platform?

Mr. ANDERSON. That is correct, sir.

Mr. KENDALL. All right. Go ahead, sir.

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1ST NAVAL DISTRICT CONFERENCE FOR PROJECT BRIEFING

Mr. ANDERSON. On March 26 we received a telephone call from Mr. Seddon of the 1st Naval District requesting us to be present at a conference at the 1st Naval District at 10 a.m., March 29, 1954. At this conference Anderson-Nichols was represented by Messrs. E. R. Anderson, John Minnich, Vincent K. Cates, and William F. Dewey. There were present at the 1st Naval District, Commander Biggs, Lt. Dave LaPorte, Commander Albers, Mr. John Taylor, and Mr. Swindells, project managers.

Senator SYMINGTON. Who was Mr. Swindells?

Mr. ANDERSON. He was a civilian employee at the 1st Naval District, and in this connection was assigned as the project manager who would work as liaison between the 1st Naval District and the architect-engineers.

Senator SYMINGTON. One other question, for clarification. You have two commanders here and a lieutenant. Who was in charge of the meeting for the Navy?

Mr. ANDERSON. I believe it was Commander Biggs.

Senator SYMINGTON. You believe?

Mr. ANDERSON. We do not have it in our notes as to who was the chairman of that meeting. But as memory serves me, it was Commander Biggs.

Senator SYMINGTON. Thank you.

Senator STENNIS. All right, proceed, Mr. Anderson.

Mr. ANDERSON. At this conference Commander Albers proceeded to give a brief description of what the project would consist of; briefly, there would be 5 towers involved approximately 75 to 100 miles off the coast, 3 to be in deep sand bottom, 1 in sand at 27 fathoms, 1, rock, 10 to 12 fathoms, and additional information such as the number of personnel to be located on the tower, et cetera, was given.

After giving this preliminary information we were asked if we would be interested in the project. Our reply was in the affirmative. We were asked if our workload was such that it would permit us starting promptly. Our answer was in the affirmative. We were asked if our organization was cleared for security. Our answer was in the affirmative. We were asked if the employment of consultants would be objectionable to us. Our answer was that undoubtedly we would do so in any case. We further stated that we had been in conference with Mr. Proctor of Moran, Proctor, Mueser and Rutledge during which conference it was agreed that if we were awarded the contract, Moran, Proctor, Mueser & Rutledge would carry the responsibility for the submarine foundation work and Anderson-Nichols would carry the responsibility for the balance.

Senator SYMINGTON. What do you mean by the submarine foundation work?

Mr. ANDERSON. I mean the design which is involved in what we call the footings or foundations, starting at the sea bottom and whatever is necessary to go below the sea bottom to give a firm structure.

Senator SYMINGTON. Starting at the sea bottom, and going below the sea bottom?

Mr. ANDERSON. That is correct, sir.

Senator SYMINGTON. What is the definition of "sea bottom"?

Mr. ANDERSON. Sea bottom is where the water ceases to exist and the soil——

Senator SYMINGTON. In other words, the construction that you had to have below the bottom of the sea; is that correct?

Mr. ANDERSON. That is correct.

SEA BOTTOM DEFINED

Senator SYMINGTON. If you will just mark on the model there, so we understand, just what you are saying, where your work started and your responsibility started and where it stopped.

Mr. ANDERSON. This might indicate it. This represents the sea bottom. It is at the end point of the legs there that you see on what is that piece of board, the board representing sea bottom. It is what is underneath that point that I refer to as submarine foundation.

Senator SYMINGTON. I am clear.

Mr. ANDERSON. Further discussion was held tending toward further clarifying the problems, et cetera, which would be involved. This conference was adjourned at 11:25 a.m.

FEASIBILITY STUDY

On April 12, 1954, a meeting was held at the District Public Works Office at 1330, with representatives of the Air Force, Lincoln Laboratory and Anderson-Nichols company present, at which time it was announced that the firms selected to do the feasibility study on Texas towers were Anderson-Nichols of Boston and Moran, Proctor, Mueser & Rutledge of New York, neither concern having any patented designs or pet schemes which they desire to sell.

On May 17, 1954, a proposal for engineering services on Texas towers, C–1901, was submitted by Anderson-Nichols and Moran, Proctor, Mueser & Rutledge, amounting to a combined lump sum fee of $140,000. That was for the feasibility report.

On June 1, 1954, a further proposal was submitted revising the cost breakdown for a lump-sum fee of $130,000 covering the feasibility study, Moran, Proctor, Mueser & Rutledge to receive $70,000, Anderson-Nichols, $60,000.

On June 1, 1954, a meeting was held at 2:43 p.m. with the Contract Board at the 1st Naval District, at which were present representatives of Anderson-Nichols and Moran, Proctor, Mueser & Rutledge, absent being Chairman of the Board, Commander Albers, and Commander Biggs acted as Chairman. The meeting opened with Mr. Proctor reading the letter of June 1 setting forth the Anderson-Nichols proposal as listed in the preceding paragraph. After considerable discussion the meeting was concluded at 3:56 p.m.

On June 22, 1954, a contract was received dated June 18, 1954, for the feasibility report in connection with Air Force project, Texas towers, for a fee of $130,000.

Senator SYMINGTON. Excuse me. What does A & E stand for?

Mr. ANDERSON. Architect engineer.

Senator SYMINGTON. Thank you.

Mr. ANDERSON. On July 22, 1954 a special conference was held in the offices of Moran, Proctor, Mueser & Rutledge in New York, attended

by representatives of the 1st Naval District and Anderson-Nichols. At this conference it was stated by Commander Albers of the 1st Naval District that his recommendations were for the purpose of expediting further caisson legs and main truss system to be assigned to Moran, Proctor, Mueser & Rutledge and the deck which sits on top of the main truss system to be assigned to Anderson-Nichols; thus each group could carry out their part of a preliminary design and evaluation more or less independently, though of course close liaison should be maintained throughout the evaluation period; Moran, Proctor, Mueser & Rutledge to submit reports summarizing their studies of the various types of tower structures and Anderson-Nichols to submit their report covering the deck or platform on top of the main truss system; these reports to be submitted to the 1st Naval District in approximately 6 weeks or as much sooner as possible. He urged that Moran, Proctor, Mueser & Rutledge reports be submitted in advance of Anderson-Nichols' report in the hope that early approval of contract 2, the detailed design contract, or design sections of the contract, might be obtained. He also stated that the Navy would not pass on superstructure, this being the function of the Air Force, and the Air Force would not pass on foundation design.

Division of Responsibility Between Architect Engineers

Senator Stennis. Would you indicate on the tower model the separation or division of responsibility? There was a definite separation of responsibility. Please point out on the tower model the work you were to have and the work Moran & Proctor was to have. The top portion of the model will come off. You can just take it off, if you wish.

Mr. Anderson. Now, to describe the divisional responsibility, after Commander Albers made this division, everything below the sea bottom and everything above the sea bottom, including this entire leg structure and the beam system, or truss system, as the expression has been used, which goes around this platform into which the legs and the connections for the legs are incorporated, is that part which Moran, Proctor did.

Senator Stennis. All right. Just lift the white top off of the model. Now, does the remaining part represent what the Proctor firm was to do?

Mr. Anderson. Not entirely. There is still incorporated in this part of the structure some design for which Moran, Proctor was responsible. They were to design the beam sections, or truss sections, which go around the platform and up into which the legs would fit. Our work at this point consisted of the architectural features involved in the platform, such as the living quarters of the men, the partitions, all mechanical work, which consisted of the power generating units, the water system, everything of a mechanical nature and the electrical system. We had to tie in with the Air Force as to the power requirements and that sort of thing. That was the part of the structure which we were given at that point.

Senator Symington. What percentage of the work was Anderson-Nichols' and what percentage was the other company, roughly?

Mr. Anderson. Well, Senator, possibly the best way for expressing that as far as the feasibility report is concerned is the amount of

money which was awarded. Moran, Proctor received $70,000, and Anderson-Nichols received $60,000, so you can use that as a percentage representing the theoretical division of work.

Now, when it came to the design contracts, that was another matter. I believe the original contract called for $150,000 to Anderson-Nichols and $450,000 to Moran, Proctor, making a total——

Senator SYMINGTON. What is the money you referred to the first time? What was that for?

Mr. ANDERSON. That was for the feasibility report.

Senator SYMINGTON. I did not understand how you used the term "feasibility report."

Mr. ANDERSON. Well, the feasibility report covered the studies which were made and the analysis of data of wind, wave action, bottom scour. It is the data which was gathered upon which the design specifications were drawn.

Senator SALTONSTALL. Mr. Chairman?

Senator STENNIS. Senator Saltonstall.

Senator SALTONSTALL. Mr. Anderson, let me ask you this question, if I may. On page 4, in the first paragraph, you stated that the Navy would not pass on superstructure, this being the function of the Air Force, and the Air Force would not pass on the foundation design. You stated just now that your part of the work would be on the platform, and above these three columns.

Mr. ANDERSON. Roughly, yes.

Senator SALTONSTALL. Now, the Secretary of the Air Force, Mr. Charyk, testified, on page 5 of his statement, that the Air Force immediately authorized J. Rich Steers, Inc. to initiate replacement of the maintenance platform, so that an underwater inspection could be made. Was the maintenance platform part of the Proctor responsibility, or your responsibility? What is the maintenance platform as it shows on the model?

Mr. ANDERSON. The maintenance platform was part of the responsibility of Moran, Proctor, Mueser & Rutledge.

Senator SALTONSTAL . Would you be able to take this model and show us?

Mr. MINNICH. Your maintenance platform is the platform suspended underneath here. It is not shown. It is a revolving walkway type of thing.

Senator SALTONSTALL. What?

Mr. MINNICH. A walkway, or a bridge, a revolving bridge that is attached under the platform and allows men to come out the bottom hatch and enter onto this revolving bridge, so that they could traverse the bottom of the tower platform for painting and other maintenance. In other words, it allows people to get out of the platform.

Senator SALTONSTALL. The maintenance platform then was not tied into any of the structure. How was it held? Was it held by suspension?

Mr. MINNICH. It was held by means of a circular track in a center pivot—a circular track around the bottom of the platform bottom, and in the center was a pivot, so that the bridge was able to rotate.

Senator SALTONSTALL. And that was the responsibility of the firm that built the structure from the water up?

Mr. MINNICH. Yes.

Senator SALTONSTALL. Thank you.

Senator STENNIS. All right. Did you have something, Senator Symington?

Senator SYMINGTON. Yes, I would like to develop this thought. You got $60,000 of the first $130,000. The actual design contract—how much of that?

Mr. ANDERSON. That was a total—that first design contract was a total of $600,000, of which we were awarded $150,000

Senator SYMINGTON. And then, as I remember it, the construction actually cost over $10 million. Were you involved in the construction, or just in the design?

Mr. ANDERSON. Purely in the design.

Senator SYMINGTON. I ask this question, with all respect, Mr. Anderson. Why, if three-quarters of the money went for the Moran, Proctor, Mueser & Rutledge Co. would the Navy go to you as in effect a prime contractor for the design? Why would they not go to a company like Moran, Proctor, Mueser & Rutledge?

Mr. ANDERSON. Well, I do not believe I can answer that question, sir. As I said originally, when this feasibility study was awarded, we were the prime contractor in the sense that we were the ones that were called in by the Navy. Later we called in Moran, Proctor, Mueser & Rutledge, and there was some question of whether Moran, Proctor, Mueser & Rutledge would be a subcontractor to us. But as we discussed it, we decided to make it a coventure.

Senator SYMINGTON. Was it a negotiated contract with you?

Mr. ANDERSON. Yes, it was.

Senator SYMINGTON. And was anybody else asked to consider it?

Mr. ANDERSON. Well, I would not be able to answer that, sir.

Senator SYMINGTON. You do not know that?

Mr. ANDERSON. No.

Senator SYMINGTON. Thank you.

Senator STENNIS. All right, proceed with your statement, Mr. Anderson.

Mr. ANDERSON. On September 23, 1954, five copies of the feasibility report on Texas tower—I might explan that the feasibility report was in two parts, part 1 being that prepared by Moran, Proctor, Mueser & Rutledge, and part 2 being that which was prepared by Anderson & Nichols.

In September 1954, Anderson-Nichols submitted part 2, or their part of the feasibility report, consisting of one set of reproducible drawings constituting recommendations for design and construction of the platform portion of Texas tower, which were forwarded to the District Public Works Officer, Air Defense Command, Ent Air Force Base, Colorado Springs, Colo., for their study and review.

On November 9, 1954, a conference was held in the office of the District Public Works Office, 1st Naval District, in which a proposal covering design services was submitted, a lump sum fee amounting to $797,460. After considerable discussion involving the items making up this fee, it was requested that further consideration be given.

On November 12, 1954, a proposal for engineering services for design was submitted to the District Public Works Office, 1st Naval District, in which it was agreed to reduce the fee of the original pro-

posals to a fee of $600,000 in view of more clarified definition of scope and services to be rendered and decisions as to items of service which if required or called for will be provided under modification of the contract.

It was stated that distribution of the total fee of $600,000 would be as follows: Anderson-Nichols, $150,000; Moran, Proctor, Mueser & Rutledge, $450,000, based on the distribution of work in the design phase as outlined previously by Commander Albers covering the feasibility study.

Detail design proceeded immediately. Work progressed from this point on as rapidly as possible toward construction of Texas tower 2.

That completes my prepared statement, sir.

Senator STENNIS. Mr. Anderson, I want to be sure that I understand this. The feasibility report, I believe, determined that the construction of such a tower was feasible. You then proceeded immediately with the second phase, is that correct?

Mr. ANDERSON. Well, I think that your question applies to part 1 of that feasibility report which work was done by Moran, Proctor, Mueser & Rutledge. We did not enter into that.

REEMPHASIS OF ANDERSON-NICHOLS RESPONSIBILITY

Senator STENNIS. I was not making reference to who prepared the report. In any event, it was decided that the construction of the towers was practical, and the Air Force and the Navy decided to proceed, is that correct?

Mr. ANDERSON. It certainly was assumed, yes, sir.

Senator STENNIS. When you moved into the second phase, did your firm have anything to do with designing that portion of the structure which is below the water?

Mr. ANDERSON. No, sir.

Senator STENNIS. You were involved, as I understand it, only with the living quarters, and some additional features.

Mr. ANDERSON. Plus the mechanical electrical features.

Senator STENNIS. Your statement refers to the design and other matters "toward construction of Texas tower No. 2." Aren't you in error as to the tower involved? You are talking about tower No. 4, are you not?

Mr. ANDERSON. Well——

Senator STENNIS. That is the one under inquiry here.

Mr. ANDERSON. That is correct.

Senator STENNIS. Which is correct?

Mr. ANDERSON. Well, at that point the design went forward on tower No. 2. It was a later date that design went forward on Texas tower No. 4.

Senator STENNIS. We are primarily interested in tower No. 4 here. What is the explanation of this statement with reference to tower No. 2?

Mr. KENDALL. I think Mr. Anderson is just giving a chronological sequence of events, and the first tower to be cranked out in the program was tower No. 2.

Senator SYMINGTON. If counsel will yield—we have had testimony this morning that the construction of the towers was entirely differ-

ent. Tower No. 4 was much the most difficult of the four towers. Therefore why does the statement stop at No. 2? Why does he not go ahead, if he had anything to do with tower No. 4?

Mr. KENDALL. Possibly Mr. Anderson can answer why he terminated his statement when he did, Senator.

Mr. ANDERSON. I think, Senator, that it was a matter of time when I stopped writing this. But my purpose in writing it was to bring out the timing and events that took place through the original contract phases of this project and up to the point when design started. Now, it just so happens——

Senator STENNIS. All right. Senator Symington requested permission to ask another question. Gentlemen, I think we better go back to the regular order as soon as we can.

Senator SYMINGTON. I am sure counsel is going to develop this, Mr. Chairman——

Senator STENNIS. Well, I think you have a good point.

Senator SYMINGTON. Well, there are two points about it. First, as I understood it from the testimony, the Navy was responsible for the design and building of the tower. Therefore, I wonder why, in your statement, you say you shipped your drawings out to the Air Force, at Colorado Springs.

Second, am I to understand that all this had to do with the tower which is not under investigation and that you, if you had more time, would have talked about the tower which is under investigation?

Mr. ANDERSON. Well, sir, actually work proceeded on the design of all towers, although the emphasis, or the priority was placed on tower No. 2 which was the first tower to be put out. However, this design, once started, went right through covering five towers.

Senator STENNIS. All right. Anything further on that?

I think, gentlemen, if we could return to the regular order it would be better.

Senator Saltonstall, you have a point. We will take you next.

SUPERSTRUCTURES FOR ALL TOWERS GENERALLY SIMILAR

Senator SALTONSTALL. Well, I just want to take that one step further. Was the superstructure which you were responsible for, any different on towers 2, 3, and 4, because of the difference in foundations underneath them, or was the superstructure the same in each one?

Mr. ANDERSON. No; it was not the same in each one, Senator. In basic principle it was the same, but details had to be changed, basically because of the change in the leg structure and the method of attaching the legs. On tower No. 4 there was a gate. Tower No. 4, as you probably are aware, was handled quite differently from either of the other two, in that the leg structure of tower No. 4 was fabricated, in essence, completely and towed to the site, whereas on the other two, these legs were put in the platform and were towed to sea as part of the platform.

On tower No. 4 the legs were towed separately, and the platform was towed separately. After the legs were up-ended and in position, then the platform was floated in between these legs and these gates were closed in order to grip the platform for raising it. Because of the difference in the detail, naturally, in our platform design, we had to make allowances for that and incorporate that.

But in basic principle, the platform was the same.

Senator SALTONSTALL. Well, who is responsible in tower No. 4 for getting the platform up from the water to the top of the structure?

Mr. ANDERSON. Well, this was a combination of the design procedure of Moran, Proctor, Mueser & Rutledge and, of course, the contractor physically doing the work.

Senator STENNIS. Will the Senator yield to me right there? It looks to me that we might as well face the fact that, while the testimony Mr. Anderson has given has relevance, we are interested primarily in the steps leading up to tower 4 which, as Senator Symington has said, presented some different problems. Mr. Anderson, himself, has said that there were differences. It would be better I think, to see if we cannot clarify what the steps were that led up to tower 4. It would save time for all of us. Will the Senator agree with that?

Senator SALTONSTALL. Yes. Mr. Chairman, I was a little confused because I thought we were talking about tower 4. I will stop right now.

Senator STENNIS. We need information about the background of the matter, and it has been very helpful to get the story of the conferences which were held and related matters. We assumed these to be applicable to tower No. 4. However, the statement of the division of fees was with reference to tower 2.

Mr. ANDERSON. Mr. Chairman, the fees applicable to tower 2 which I quoted apply to all five towers.

Senator STENNIS. All right.

Mr. ANDERSON. And I think that the statement that I read is just as applicable to tower No. 4 as it was to towers No. 2 or No. 3.

Senator STENNIS. All right. Well, that is enlightening. Perhaps counsel has something to bring out here. Let's see, gentlemen. Let's move right into this tower 4. That is the inquiry.

Mr. KENDALL. Mr. Anderson, as I understand it, the Feasibility Study and your contract with the Navy covered all five towers, is that right, originally?

Mr. ANDERSON. That is correct.

Mr. KENDALL. In other words, it covered towers No. 2, No. 3, and No. 4, the ones that were actually built?

Mr. ANDERSON. 1, 2, 3, 4, and 5.

Mr. KENDALL. And this sequence of events which you have related is equally applicable to any one of the towers, is that correct?

Mr. ANDERSON. That is correct, sir.

Mr. KENDALL. So that your statement does apply to the background information of the contractual relationship between you and Moran, Proctor——

Mr. ANDERSON. As it was involved in tower No. 4.

Mr. KENDALL. As it was involved in tower No. 4?

Mr. ANDERSON. That is correct.

Mr. KENDALL. Does that help you any, Senator?

Senator STENNIS. It does. Proceed.

Mr. KENDALL. As I understand it, you originally brought Moran, Proctor into this picture.

Mr. ANDERSON. That is correct.

DIVISION OF RESPONSIBILITY BETWEEN ARCHITECT ENGINEERS

Mr. KENDALL. And the original agreement of division of the work was that you were to have everything above the floor of the sea; is that right?

Mr. ANDERSON. That is correct.

Mr. KENDALL. This was a matter of agreement between you and Moran, Proctor?

Mr. ANDERSON. That is right.

Mr. KENDALL. Now, when was that changed, and by whom?

CHANGE IN DIVISION OF WORK

Mr. ANDERSON. That was changed at a meeting held in the offices of Moran, Proctor, Mueser & Rutledge on July 22, at which it was stated by then Commander Albers that for the purpose of further expediting the work, caisson legs and main truss system would be assigned to Moran, Proctor, Mueser & Rutledge.

Mr. KENDALL. Excuse me. Do I understand that Captain Albers intervened and dictated a change in your contractual relationships with Moran, Proctor?

Mr. HOLBROOK. Mr. Counsel, does this call for his direct knowledge?

Mr. KENDALL. If he has any knowledge; yes.

Mr. ANDERSON. Sir, I cannot give the reason for that.

Mr. KENDALL. Well, is it a customary thing for a naval officer to intervene in your private contractual relationships and tell you how you must change it?

Mr. ANDERSON. Well, it is a bit unusual, sir.

Mr. KENDALL. Do you have any idea of why that came about, or why it was done?

Mr. ANDERSON. Personally, I do not have, sir.

Mr. KENDALL. Do you have any opinion or judgment?

Mr. ANDERSON. I do not, sir.

Mr. KENDALL. But in any event, thereafter, and as the tower was actually constructed, your responsibility was only for the platform layout, the housekeeping portions of it?

Mr. ANDERSON. That is right.

Mr. KENDALL. And you had nothing to do with the design of the legs and the supporting structure, is that correct?

Mr. ANDERSON. That is correct.

Mr. KENDALL. If you had participated in the design of the legs and supporting structure, would you have made any changes in the specifications?

Mr. HOLBROOK. Is Mr. Counsel calling for a professional opinion as to scope that Mr. Anderson did not have?

Mr. KENDALL. I am asking what he would have done if he had been in that position.

Mr. ANDERSON. Well, sir, in answer to that, I would say it would be very difficult for me to say to what degree we would have done things differently.

INADEQUACY OF DESIGN

Mr. KENDALL. Well, do you have any opinion as to the adequacy or sufficiency of the structure as designed?

Mr. ANDERSON. Well, I think that it is apparent to all that there were certain inadequacies. But I have no opinion. In other words, I did not participate in formulating the design criteria.

Mr. KENDALL. Well, for example, Mr. Anderson, would you have used pin connections if you had been designing this tower?

Mr. ANDERSON. Again, that is very difficult to say. I would question very much that we would.

Senator STENNIS. What was that, please?

Mr. ANDERSON. I said I would question that we would be using pin connections.

Mr. KENDALL. Why wouldn't you have used them?

Mr. ANDERSON. This would be a matter of structural design, and I do not believe that we would approach it quite that way. This system of bracing, as I know it, was a patented design, and I do not know whether pin connections were part of that or not.

Mr. KENDALL. I did not get that last statement.

Mr. ANDERSON. I say, as I know it, this bracing system in which these pin connections were used was a patented design, as I have been told. And whether the pin connections are part of that patented design, I am not in a position to say.

Mr. KEDALL. Well, can you explain briefly what we are talking about when we are talking about pin connections, as distinguished from welded connections?

Mr. ANDERSON. I do not think it shows on the model.

Mr. MINNICH. It is not shown on the model.

Senator STENNIS. Were you sworn a while ago?

Are there any others to testify here on these points?

SWEARING IN OF ADDITIONAL WITNESSES

Mr. ANDERSON. Mr. Rolland may.

Senator STENNIS. All right.

Hold up your right hand.

Do you solemnly swear that your testimony in this hearing will be the truth, the whole truth, and nothing but the truth, so help you God?

Mr. MINNICH. I do.

Mr. ROLLAND. I do.

Mr. MINNICH. John Minnich, chief structural engineer.

Mr. ROLLAND. Martin G. Rolland, chief mechanical engineer.

Mr. MINNICH. Do you want me to answer that?

Mr. KENDALL. Yes, sir; if you will, Mr. Minnich.

Mr. MINNICH. A pin connection is simply a structural connection in which a steel pin is placed in previously drilled holes to make a connection, in contrast to other types, such as welding, where the members are joined directly by means of welding.

Is that clear enough?

Mr. KENDALL. Since the subject is going to be discussed, I thought we ought to have something in the record on this point.

Is one apt to be more rigid than the other? I am still discussing a weld as against a pin connection?

Mr. MINNICH. Generally speaking, a welded connection is characteried by a greater rigidity than a pin connection. Sometimes it is advantageous not to have too much rigidity, and in that case, a pin is

usually used. However, I believe that the whole subject of design there is too extensive to go into. It is certainly conceivable that any degree of rigidity could be obtained by any method, perhaps at a different cost. It is a matter of choice there.

I assume that a pin connected job could have been designed for almost any degree of strength and rigidity. It would not normally be the choice where you were choosing rigidity as a desirable quality.

Mr. KENDALL. Do you concur generally with Mr. Anderson's statement that if you had been the designer, you probably would not have used pin connections?

Mr. MINNICH. I do not believe I can answer that question. I have never—I was not, you know, in on the decisions that went along with that. And also, Mr. Anderson has already stated that the design of the Tower No. 4 leg structure was a part of a patented system, and perhaps that may have—I have no knowledge of that—whether that pin connection was part of the patent or not.

Mr. KENDALL. Mr. Anderson, I have in my hand here a document that is entitled "Design and Construction Report on the Texas Towers Offshore Radar Platforms," and the date is September, 1959. Your name appears upon this document.

What part, if any, did your firm have in the preparation of this?

Mr. ANDERSON. None.

Mr. KENDALL. Who prepared it?

Mr. ANDERSON. Moran, Proctor, Mueser & Rutledge.

Mr. KENDALL. Were you consulted about it?

Mr. ANDERSON. No.

Mr. KENDALL. Prior to its being prepared?

Mr. ANDERSON. No; we were not.

Senator STENNIS. Let the item that counsel and the witness are referring to in their questions and answers be identified.

Mr. KENDALL. If we may, we will consider this a part of our official files.

Senator STENNIS. All right. It is so ordered.

Proceed.

Mr. KENDALL. That is all I have.

Senator STENNIS. Do you think, Mr. Anderson, that you have brought out the main high points now, which led up to this contract?

Mr. ANDERSON. I believe so, sir.

Senator STENNIS. Now, at this conference on July 22, 1954, Captain Albers informed you that for the purpose of expediting the project, the caisson legs and main truss system were to be assigned to Moran, Proctor, Mueser & Rutledge, and the deck which sits on the top would be assigned to your firm. Now, what reason did he give for assigning one part of it to you and one part to the other firm?

REASON FOR CHANGE IN DIVISION OF WORK BETWEEN ARCHITECT ENGINEERS

Mr. ANDERSON. I know of no other reason than, as I stated, in the interests of expediting the work.

Senator STENNIS. Were you in that conference yourself?

Mr. ANDERSON. I was not personally there; no, sir.

Senator STENNIS. Did you have a representative there?

Mr. ANDERSON. Yes; I did.

Senator STENNIS. Who represented you?

Mr. ANDERSON. I think Mr. Minnich was there.

Mr. MINNICH. I was there.

Senator STENNIS. This was a change of responsibility, was it not?

Mr. MINNICH. Yes, sir. It changed the understanding somewhat.

Senator STENNIS. Well, it changed the understanding. Did you not question the reason at that time?

Mr. ANDERSON. Well——

Senator STENNIS. Pardon me; my question is directed to this gentleman over here.

Mr. MINNICH. No; I do not believe so.

Senator STENNIS. Why did you not?

Mr. MINNICH. I don't know.

Senator STENNIS. Well, there was a change in the division of work, and later there was a change in the basic design, as I understand it. Ultimately, there was used a patent which belonged to an employee of the other firm. I cannot understand why it was not questioned more than it was.

Mr. MINNICH. Well, let me attempt to answer it this way:

This was in the feasibility study. This was not in the design part of it. It seemed reasonable, or fairly reasonable, that it was an expediting matter, that if we arbitrarily made a division of the work at one place, that it would expedite the feasibility report.

I did not consider at that time it was a commitment for the same division to be carried on into the design. I thought that probably would be reconsidered in due time.

Senator STENNIS. Did you think they would revert to the original proposition and not have the same division of contracts as to design?

Mr. MINNICH. No. I mean that I did not think the line of demarcation at that time was necessarily the same one that was to be later used in the design phase. So for that reason I did not particularly question the assignment of work then, because I believed that it was a matter of expediting the report.

Senator STENNIS. As a matter of fact, was it not more practical, to recognize that this was actually a division of the contract and a division of the work, and that you were out of it from there on, so far as the design of this structure below the water was concerned? Isn't that correct?

Mr. MINNICH. Well, not only below the water, but below the deck.

Senator STENNIS. Yes, below the deck.

Mr. MINNICH. Well, as far as the feasibility report, that certainly was true.

Senator STENNIS. Wasn't it also true as to the design of the structure itself? Didn't you consider, when you left that conference, that this was a definite division and would be followed in the future?

Mr. MINNICH. Yes, I thought it indicated that might be the trend. And I reported to Mr. Anderson what was done at the conference. And I didn't think it was my prerogative to make any statement at the conference—that is, that should be made afterwards by Mr. Anderson.

Senator STENNIS. All right. That is your answer. You made that clear. Mr. Anderson, you heard the answer. What did you do? Did you realize that this was a definite division of this matter and did you protest it?

Mr. ANDERSON. I did at one point later. In this connection, there were a whole series of conferences between two or more individuals that were going on almost daily on various angles.

Speed was one of the factors so that everybody was working day and night on it. At that point, as far as the gathering of data is concerned, basically it all fell into the Moran, Proctor, Mueser & Rutledge domain because of the bottom scour and so forth, and that same data would be used in the structural design of legs and so forth.

And while it appeared to me as taking a little swerve from the original concept of the division of work, at least there was some reason for it. And as Mr. Minnich stated, this was purely a feasibility study. We did not know at this point whether we would be given the design contract or not. We could assume that it would be logical to do it, but we could not be sure of that, and there had been no discussion of the design contract at this point, so it was not a circumstance that I cared to make an issue about at that time.

Senator STENNIS. All right. My time is up. Senator Saltonstall, do you have some questions there?

Senator SALTONSTALL. Mr. Chairman, I have just a few questions.

Senator STENNIS. All right.

Senator SALTONSTALL. Mr. Anderson, the original feasibility contract, as to investigating the size and force of the waves and so forth was done jointly with this New York firm of Moran, Proctor, Mueser & Rutledge, was it not?

Mr. ANDERSON. No. We took that phase of the work.

Senator SALTONSTALL. So that you had no responsibility as to whether these towers were feasible or not? I thought you said you did.

Mr. ANDERSON. Senator, from the standpoint of the structural part of the tower, we felt it was feasible to put a stationary platform in water at those depths, no question about it. There still is no question in our mind that it can be done.

FEASIBILITY OF TOWERS AGREED TO

Now, as to the feasibility of the particular structural system that was suggested and later accepted, we did not have the responsibility.

Senator SALTONSTALL. In other words, you and the Rutledge firm agreed that these towers were feasible.

Mr. ANDERSON. This is correct.

Senator SALTONSTALL. And then you separated after that as to the responsibility. Your responsibility was for the design of the platform and everything up above the platform, and they were responsible for everything below the platform, is that correct?

Mr. ANDERSON. That is correct, yes.

Senator SALTONSTALL. And you had no part in the design of the structure below the platform?

Mr. ANDERSON. This is correct.

Senator SALTONSTALL. Now——

Senator STENNIS. Will the Senator yield to me on that point? I think you brought out a good point. For instance, were there questions in your mind as to the wisdom of a three-legged tower? Did

you have any reservations on that proposition? I believe that you agreed that an offshore tower was feasible; is that right?

Mr. ANDERSON. I do not believe that I stated that we had reservations, in answer to Senator Saltonstall's question. I did say that Moran, Proctor, Mueser & Rutledge and ourselves agreed that such a project would be feasible.

Senator STENNIS. Well, did you have any reservations about a three-legged tower?

Mr. ANDERSON. Did I have any reservations?

Senator STENNIS. Yes.

Mr. ANDERSON. Not as such, no.

Senator STENNIS. Excuse me. Thank you, Senator.

Senator SALTONSTALL. Now, you stated on page 4 of your statement that the Navy would not pass on the superstructure, this being the function of the Air Force, and the Air Force would not pass on the foundation design. Does that mean that your design for the superstructure was passed on by the Air Force as a part of the original design?

Mr. ANDERSON. Sure——

Senator SALTONSTALL. I did not gather from the testimony of the Air Force——

Mr. ANDERSON. Sir, when that statement was made my understanding of its meaning was that the Air Force would pass on that phase of the work which we were doing because it involved the living quarters of the men, it involved the requirements of the radomes, all that type of item. And the Navy, I suppose, considered that it could be better done by the Air Force than the Navy. So that our contract, as far as the details of that design and so forth were concerned, was handled more directly with Air Force than it was with Navy.

Senator SALTONSTALL. Well, who was responsible for the structural strength of the platform—the Navy or the Air Force?

Mr. ANDERSON. The structural strength—I would say that the Navy was responsible for that.

Senator SALTONSTALL. So you might say the Air Force was only responsible for the design of the cabin, where the bunks should go and all that?

Mr. ANDERSON. That is correct; together with such power and water requirements, and so forth, as they felt they needed.

Senator SALTONSTALL. Were you responsible for seeing that the work by the contractor was carried out on the superstructure?

Mr. ANDERSON. No, sir.

Senator SALTONSTALL. Who was responsible for that?

Mr. ANDERSON. This was under the 1st Naval District.

Senator SALTONSTALL. So that, after you had performed your design work, and had drawn the plans as an architect or designing engineer, you did not have any responsibility for seeing that that work was done in accordance with your designs? I am surprised that that is true.

Mr. ANDERSON. Well, we did not have that responsibility, although there were many instances in which we were consulted about various phases of it. But we did not supervise the construction of that portion of the work.

Senator SALTONSTALL. All right. Now let me ask you just one final group of questions.

It was my understanding that tower 4 was different from the other two towers because the superstructure had to be floated out there and jacked up, and was not put out there on top of the legs; is that correct?

Mr. ANDERSON. May I just change that wordology a little bit. It is not because the tower was floated out. It was because of the design of the leg and truss system, as some call it, or, as I choose to call it, the beam construction of the platform itself. And it was the design of that which made it necessary for us to make minor changes in the design of the platform itself—not the fact that it was floated out.

Senator SALTONSTALL. Well, you mean that the superstructure, for which you were responsible for designing, was sufficiently different because of the structure of the underpinning and the legs, and the method of putting them together was not the same as with the other two towers.

Mr. ANDERSON. That is correct; yes, sir.

Senator SALTONSTALL. Now, did the placing of the superstructure onto the legs, in the case of tower 4, in your opinion, weaken, in any way, the legs on which it was to rest?

Mr. ANDERSON. I want to be sure I understand your question, Senator.

Senator SALTONSTALL. What I am trying to bring out is this: Was there any difference, because of the difference in design of the legs, as to the strength, overall, of the structure due to the means by which the superstructure was put on top of it?

Mr. ANDERSON. The fact that the superstructure was put on top of it I would not say was a factor in the strength. The leg system was designed to take the weight which would be involved in the platform that was going to be placed on top of the legs, or rather on top of the beam structure which tied the legs together.

Senator SALTONSTALL. Well, I am not an engineer and it is very difficult for me to state these questions clearly. Is it not true that some of the support or some of the structural braces had to be different on tower 4 than on the other two towers when they were being put in place?

Mr. ANDERSON. They were different.

Senator SALTONSTALL. All right. Now, could you point out which ones were different? Does it show on the model?

DIFFERENCES BETWEEN THE TOWERS

Mr. MINNICH. The difference in the towers is shown by the two models you have here. All of this bracing is absent in Texas towers No. 2 and No. 3. There was no bracing in these. It would be those legs, with this platform.

Senator SALTONSTALL. Tower 4 in its structure was sufficiently different because of the braces, and the braces would cause greater wave resistance and resistance to water currents and everything else than those three columns on the model of Texas tower No. 2.

Mr. MINNICH. Well, yes, sir. That is true. But, even though the braces pick up more resistance, they are also more effective struc-

turally in bracing the legs, so that you still have a clear gain. There are two different conceptions used here. I do not know how far you want to go into it. But in this case you have essentially what we call a rigid frame which acts to resist lateral forces merely by the moments created in the elements that you see—the legs. In this case, we have—by means of the bracing—built up a truss plane which resists the lateral forces as a unit, which is quite different in principle in the two structures. And, therefore, the mere fact that these braces do pick up more resistance from the waves, which is unavoidable, you have to have them in the deep water because of the larger structural——

Senator STENNIS. Excuse me just a moment. I must go. Will you gentlemen excuse me now, and just proceed as you wish. Senator Symington will preside. I hope it is all right with the committee—2:30?

Senator SALTONSTALL. Mr. Chairman, I must leave too; right now.

Senator STENNIS. When we do recess, it will be until 2:30. I hope you can come back.

Senator SALTONSTALL. Senator Symington, may I ask one more question?

Now, Mr. Anderson, was the weight of the superstructure on tower 4 any different than on towers 2 and 3 because of the difference in the underpinning?

Mr. ANDERSON. There was no material difference in weight.

Senator SALTONSTALL. So that from your point of view, in designing the superstructure, you relied on the Rutledge firm to design the underpinning from the superstructure down sufficiently strong to take the same design that you put on for towers 2 and 3.

Mr. ANDERSON. That is correct.

Senator SALTONSTALL. Mr. Chairman, that is all I have.

Senator SYMINGTON. Thank you. As I understand, when you were approached first by Mr. Seddon, Mr. Anderson, Moran Proctor would do the submarine foundation work and you were going to do the superstructure work; is that correct?

Mr. ANDERSON. That is correct; yes, sir.

Senator SYMINGTON. And later on there was a special conference on July 22, 1954. Why do you call it a special conference?

Mr. ANDERSON. Well——

Senator SYMINGTON. What was unusual about the conference?

Mr. ANDERSON. There was nothing unusual. There were a whole series of conferences of this type. This particular one was held in New York.

Senator SYMINGTON. Well, I wondered why you said "special."

Mr. ANDERSON. Well, that is the way the minutes were written. It is called a special conference. I do not think it was particularly significant.

Senator SYMINGTON. At this conference Commander Albers apparently told you that you were going to get a lot less of the work than you thought you were going to get when you asked the Rutledge firm to come in; is that correct?

Mr. ANDERSON. That is what the division of work resulted in; yes.

Senator SYMINGTON. And that is when you first knew about it?

Mr. ANDERSON. That is correct.

Senator SYMINGTON. Why do you think that was done?

Mr. ANDERSON. Only as I have previously stated, that Commander Albers gave as the reason that he felt it would expedite the work on the report. The time allowed, or the requested time in which this report was to be completed—they wanted the finished report in—was a very short period of time to get the mass of material and data together on which to make this feasibility study.

Senator SYMINGTON. Were you satisfied with that decision?

Mr. ANDERSON. Was I at that time?

Senator SYMINGTON. Yes.

Mr. ANDERSON. Yes.

Senator SYMINGTON. Did you ever have any discussion or argument with the Rutledge firm?

Mr. ANDERSON. No.

Senator SYMINGTON. You did not feel that they had moved in on you, even though you got them as a subcontractor?

Mr. ANDERSON. Not at this point, sir, because it was—it looked like good commonsense.

Senator SYMINGTON. Well, at what point did you feel that way?

Mr. ANDERSON. How was that?

Senator SYMINGTON. I said at what point did you feel that way?

Mr. ANDERSON. At the time that the design contract itself was awarded.

Senator SYMINGTON. Well, now, your man was at the meeting, and he did not protest but he told you about it. It seems to me that if you are out on feasibility, you automatically would guess that you would be out on design. Didn't you have that feeling?

Mr. ANDERSON. I certainly felt that it probably would go that way; yes, sir.

Senator SYMINGTON. All we are trying to do is locate responsibility.

Mr. ANDERSON. Yes, I understand that.

Senator SYMINGTON. And up to this time, had anybody from the Air Force contacted you?

Mr. ANDERSON. In relation——

Senator SYMINGTON. In relation to the contract.

Mr. ANDERSON. No.

Senator SYMINGTON. And when did you have your first contact with the Air Force?

Mr. ANDERSON. Well, the Air Force was present at most of the meetings that we had after the contract for the feasibility report was awarded. In other words, they were supplying——

Senator SYMINGTON. They were at these meetings, were they? The Air Force?

Mr. ANDERSON. They were at most meetings. On this particular meeting, they were not represented.

Senator SYMINGTON. Well, I do not see any reference to any Air Force people at these meetings. For the record, would you establish what Air Force people were at what meetings that you referred to in here? Would you supply that for the record?

Mr. ANDERSON. Well, may I say this—that to answer your question, it would be necessary for me to refer to material that I cannot very well do at this moment.

Senator SYMINGTON. That is why I asked you to supply it for the record in the next few days.

Mr. ANDERSON. I would like to supply it later.

(The information requested is as follows:)

MEMORANDUM

ANDERSON-NICHOLS & CO., INC.,
April 12, 1954.

Subject: Conference report—Texas towers.

A meeting was held at the District Public Works Office on April 12, 1954, 1330, with representatives of the Air Force, Lincoln Laboratory, and A. & E. contractor to discuss subject project in a general way.

The following were present:

Capt. Wm. F. Wesanen	District Public Works Office.
Comdr. J. J. Albers	District Public Works Office.
Comdr. F. L. Biggs	District Public Works Office.
Mr. R. S. Seddon	District Public Works Office.
Mr. S. S. Swindells	District Public Works Office.
Lt. Col. L. B. Reppert	USAF IRO NED
Lt. Col. J. L. Crossey	HQ USAF ACS/1 Pentagon
Lt. Col. C. S. Glenn	HQ ADC (Directorate of P. & R.)
Maj. R. P. Hjelm	HQ EADF Programing
Maj. R. M. Hairston	ADC Liaison Officer—Lincoln Lab.
Maj. L. D. King	Dir. of Comm. HQ USAF
Capt. H. H. Lewis	HQS EADF (Ops. & Tng.)
Capt. J. W. Menard	HQS EADF (Comm. and Electronics)
Capt. P. R. Knight	US AFIRO—NED Boston
Mr. Phil G. Carney	Rome Air Force Depot (MRMNS)
Mr. A. C. Anderson	USAF IRO NED Boston
Mr. M. Morelli	Rome Air Force Depot (MRMNSS)
Mr. F. S. Kline	AFCRC (USAF) Cambridge
Mr. K. T. Lord	Dir. of Installation, HQ EADF
Mr. H. W. Bashore	Construction Div., Directorate of Install. (HQ ADC)
Mr. R. T. Story	Rome Air Force Depot (MRMNSS)
Mr. H. L. Messinger	Rome Air Force Depot (MRMNN) Wire Comm.
Mr. R. E. Rader	Planning & Control Off.—Lincoln Lab.
Mr. J. Churchill	Planning & Control Off.—Lincoln Lab.
Mr. E. Ross Anderson	Anderson-Nichols & Co., Boston
Mr. Carlton S. Proctor	Moran, Proctor, Mueser & Rutledge, New York City

Lt. Col. Reppert stated that he was responsible for monitoring the design and construction for the Air Force.

Senator SYMINGTON. The reason for my question is that the Under Secretary of the Air Force testified this morning responsibility for design and construction was given to the Navy—period—no reservation. In your statement you say that Commander Albers—

stated that the Navy would not pass on superstructure, this being the function of the Air Force, and the Air Force would not pass on foundation design.

Some men lost their lives as a result of this tower falling down. And yet, already we have a split opinion before this committee. You have a clear-cut difference of opinion as to where responsibility and authority was or was not.

You were here this morning, and you heard Secretary Charyk's testimony, did you not?

Mr. ANDERSON. I heard that, yes.

Senator SYMINGTON. Well, that testimony is not in accordance with the statement you made as to what Commander Albers told you; was it?

Mr. ANDERSON. You can interpret it that way.

Senator SYMINGTON. Well, how do you interpret it?

Mr. ANDERSON. Well, I interpret it that in this particular connection, that this basically was for the approval of drawings.

Senator SYMINGTON. Well, would you say that approval of drawings was approval of construction but not approval—what is the point about that? If you approved the drawings, you approve the structure, don't you?

Mr. ANDERSON. That is correct.

Senator SYMINGTON. The Air Force testified this morning that they had no responsibility for the structure, that they gave the job to the Navy and the Navy took the responsibility.

Mr. ANDERSON. Well, sir, I do not believe that the Air Force had any responsibility for construction as such.

Senator SYMINGTON. Now, let me read you what you said.

Mr. ANDERSON. What I refer to is the quarters which are involved in the platform.

Senator SYMINGTON. Let me read you what you say here.

Mr. ANDERSON. The architectural details.

Senator SYMINGTON (reading):

> Commander Albers stated that the Navy would not pass on superstructure, this being the function of the Air Force, and the Air Force would not pass on foundation design.

And then you state that you sent five copies of the feasibility report on the Texas tower, and so forth, to the Air Force.

I am trying to get clear on this. Would you say that there was a change from the feasibility aspect and the design aspect, and that the Navy took control of the design, for which you got the $600,000?

Mr. ANDERSON. Mr. Chairman, I would like to try and clarify.

Senator SYMINGTON. All right.

Mr. ANDERSON. That design at this point was not involved.

Senator SYMINGTON. I understand that. You had a feasibility contract.

Mr. ANDERSON. And the portion or the part 2 of this feasibility report, which was the material that we sent to the Air Force for their inspection—the reason for it being that this was the material which showed the types of accommodation we were providing for their men, such as toilets, showers, and all that, and we wanted their approval of that before we submitted the feasibility report to the First Naval District, and in turn, to the Bureau of Yards and Docks.

That was the purpose that that was sent to the Air Force.

Senator SYMINGTON. That is not superstructure, is it?

Mr. ANDERSON. No, sir.

Senator SYMINGTON. All right. Now, Commander Albers—and this is your statement—"stated that the Navy would not pass on superstructure."

Mr. ANDERSON. I think it is a question of the meaning of the word "superstructure." You could say that superstructure was everything from the ocean bottom up. But I think——

Senator SYMINGTON. That is what you, in effect told us an hour or so ago.

CLARIFICATION OF SUPERSTRUCTURE DEFINITION

Mr. ANDERSON. But in the sense that I think that Commander Albers was using this, he called the platform part the superstructure. And I think that it was in that respect that he was referring to the fact that the Navy would not have the responsibility for that portion and the Air Force would not have the responsibility for what is below the platform.

Senator SYMINGTON. In other words, your understanding of what superstructure is and Commander Albers' understanding of what superstructure is are different.

Mr. ANDERSON. In that sense, yes. In other words, I could call superstructure everything from the floor bottom up. However, in the sense that it is being used here, it is from the platform down.

Senator SYMINGTON. Before we stop, I want to be sure that we understand. You believe that the Navy was stating that the Air Force was responsible for everything above—mark it there, please, take your hand and say what you think Commander Albers meant to the best of your knowledge.

Mr. ANDERSON. The beam structure, which is not shown here, but which is a part, let's say, of the outer periphery of this platform, and which is the structural system which ties these legs together at the top, that portion, and everything below was what I understood was being referred to.

Senator SYMINGTON. By whom?

Mr. ANDERSON. In Commander Albers' statement.

Senator SYMINGTON. What part of it was Commander Albers telling you that the Air Force was responsible for?

Mr. ANDERSON. It is this upper part of this platform which involved the radomes, involved the diesel electric generators for their power, involved the type of living quarters that they were having—this type thing. It had nothing to do with the structure as such.

Senator SYMINGTON. Therefore when you use the word "superstructure" you are not using it, in this statement, the way you explained what the superstructure was earlier in the testimony?

Mr. ANDERSON. That is right.

Senator SYMINGTON. Thank you.

We will recess until 2:30 this afternoon.

(Whereupon, at 1:10 p.m. the hearing was recessed until 2:30 p.m. of the same day.)

AFTERNOON SESSION

Senator SALTONSTALL (presiding). The Acting Chairman is informed that Capt. John J. Albers is the first witness.

Is Captain Albers here?

Captain DAVIS. If it please the committee, I am Capt. Will J. Davis, U.S. Navy, legal officer, Bureau of Yards and Docks, a Navy legal specialist and a member of the bar of Indiana.

I have with me Capt. John J. Albers, the officer in charge of construction for the design of the tower; and likewise Rear Adm. W. C. G. Church (CEC), U.S.N., Assistant Chief, Bureau of Yards and Docks,

for construction; and two civilian specialists, Mr. Gordon C. Edwards, construction management engineer; and Mr. James Ayers, underwater consultant, Bureau of Yards and Docks.

Senator SALTONSTALL. Will all these gentlemen testify?

Captain DAVIS. I would request, please, that they be sworn in case they have to testify.

Senator SALTONSTALL. Do you solemnly swear that the evidence you shall give in this hearing shall be the truth, the whole truth, and nothing but the truth, so help you God?

Admiral CHURCH. I do.

Captain ALBERS. I do.

Mr. AYERS. I do.

Mr. EDWARDS. I do.

TESTIMONY OF CAPT. JOHN J. ALBERS (CEC), U.S.N.; REAR ADM. W. C. G. CHURCH (CEC), U.S.N., ASSISTANT CHIEF, BUREAU OF YARDS AND DOCKS; JAMES AYERS, UNDERWATER CONSULTANT; AND GORDON C. EDWARDS, CONSTRUCTION MANAGEMENT ENGINEER; ACCOMPANIED BY CAPT. WILL J. DAVIS, U.S. NAVY, LEGAL OFFICER, BUREAU OF YARDS AND DOCKS

Senator SALTONSTALL. Now, Captain Albers, do you have a prepared statement?

Captain ALBERS. Yes, sir; I do, principally it is an introduction of myself and my qualifications.

Senator SALTONSTALL. Then will you proceed with the reading of your statement?

Captain ALBERS. Currently, I am assigned as public works officer at the Puget Sound Naval Shipyard and resident officer in charge of construction in the Bremerton, Wash., area.

I have been a civil engineer since graduation from Vanderbilt University in 1933, and have had 20 years' experience in the Civil Engineer Corps of the Navy, much of which has been spent in the field of heavy marine construction including drydocks, breakwaters, quaywalls, and piers. I have with me a detailed résumé of my background which I will gladly submit if the committee wishes.

As deputy district public works officer, First Naval District, Boston, Mass., during initial phases of the Texas tower program and as officer in charge of construction of Texas tower contracts from January 1955 through December 1956, I was responsible for both the design and construction of Texas towers No. 2 and No. 3, and the design only of Texas tower No. 4.

I was one of the members of the board designated to recommend the architect and engineering group which was selected for the work and which ultimately prepared the feasibility study and later the design for all of the towers.

The selected joint venture composed of Anderson-Nichols of Boston, and Moran, Proctor, Mueser & Rutledge, New York, was considered eminently qualified for a project of this nature. Anderson-Nichols had considerable experience and reputation as industrial engineers in the design and layout of equipment and electrical sys-

tems and Moran, Proctor, Mueser & Rutledge of New York City are internationally known engineering consultants in the field of marine structures.

The designers, after extensive research and consultation with many oceanographic authorities, developed the wave and wind criteria and design procedures which were approved by myself, the District Public Works Officer, 1st Naval District, the Bureau of Yards and Docks and the U.S. Air Force.

APPROVAL OF DESIGN CRITERIA

I would like to interrupt myself at this time because that appears to be in conflict with the testimony of the Secretary.

By that, I mean that the Air Force did approve the feasibility report, which included as a portion of it these design criteria.

I interpret that as meaning they approved.

Likewise, they were reviewed by Bretschneider and Reid of Texas A. & M., eminent experts in the field of oceanography, who concurred with the established criteria. The structural members were so designed that the stresses resulting from the application of the wind and wave criteria were kept within normal engineering limits. In short, we took pains to insure that the structural members would not be overstressed.

KNOWLEDGE LIMITED CONCERNING STRUCTURES BUILT IN OPEN OCEAN

It should be noted that these towers were the first structures ever built in the open ocean anywhere and that very little reliable data existed at that time on wave heights and wave forces to be expected at sea. Although experience on the Texas towers has increased our knowledge in this area, it is still very limited today.

Previous experience with offshore oil drilling platforms in the Gulf of Mexico was reviewed in detail but was of limited value due to the much more severe wave conditions expected in the Atlantic Ocean.

Therefore, data was solicited and obtained from all known authoritative sources on which to base design criteria.

Competitive bids were received on November 1, 1955, for the construction of Texas towers Nos. 1, 3 and 4. The bids were submitted to the Bureau of Yards and Docks and, in turn, to the U.S. Air Force, which Department then allocated funds for the construction of only towers No. 3 and No. 4.

A lump sum contract was then awarded to the joint venture of J. Rich Steers of New York and Morrison-Knudsen of Boise, Idaho, both very reputable heavy construction contractors and who had submitted the low bid for these towers.

I would like to emphasize that these towers were unique in engineering history and presented many design and construction problems never experienced before.

All firms directly associated with the program were established concerns, well qualified in their respective fields.

I trust we can establish to the satisfaction of all concerned that the tragic loss of Texas tower No. 4 was more an act of God than of man.

It is my understanding that there will be a movie now, sir.

Senator SALTONSTALL. If the counsel would delay asking his questions, there are one or two questions I would like to ask you before we have the movie.

You stated, on page 1 of your statement:

> I was responsible for both the design and construction of Texas towers 2 and 3, and the design of Texas tower 4.

Why do you draw a distinction between the design of Texas tower 4 and its construction, and the design and construction of Texas towers 2 and 3?

Captain ALBERS. I was detached from the program prior to the actual construction of Texas tower 4, sir.

Senator SALTONSTALL. You stated that you were one of the members of the board designated to recommend the architect and engineering group.

Captain ALBERS. The other members were Mr. Seddon, Mr. Taylor, Commander Biggs, and Lieutenant LaPorte.

Senator SALTONSTALL. There were two civilians there?

Captain ALBERS. Yes, sir.

Senator SALTONSTALL. What were their names again?

Captain ALBERS. Mr. Seddon.

Senator SALTONSTALL. What was his job?

Captain ALBERS. He is the Chief Design Engineer for the DPWO, District Public Works Office, of the 1st Naval District.

Senator SALTONSTALL. And who is the other civilian?

Captain ALBERS. Mr. Taylor. He is the chief civilian in the construction end of the District Public Works Office, 1st Naval District. All members are members of the 1st Naval District staff.

Senator SALTONSTALL. Mr. Anderson testified this morning that the responsibility was divided into two parts, first as to feasibility.

Captain ALBERS. That is correct, sir.

Senator SALTONSTALL. You selected Anderson-Nichols, of Boston, and this Rutledge firm in New York to undertake the feasibility study?

Captain ALBERS. We made the recommendations that they be selected; yes, sir. We did not have the authority to make the actual selection.

Senator SALTONSTALL. Did you make that request of Anderson-Nichols, and pursuant thereto he got the other firm, as Mr. Anderson testified this morning, or did you select the Rutledge firm as well as the Anderson firm?

Captain ALBERS. We selected them as a joint venture, Mr. Chairman. We wanted the experience of both firms in on this program.

Senator SALTONSTALL. Now, they did the feasibility study, to determine feasibility. And, as Mr. Anderson testified this morning, there was no question in his mind but what Texas towers were feasible.

Now, you say that you were responsible for the design. Did you do the technical work or did you leave it to these two firms?

Captain ALBERS. I was the administrative officer in charge of construction for that contract. I reviewed their design as I deemed necessary; yes, sir.

Senator SALTONSTALL. Who determined the division of the work between them?

DIVISION OF RESPONSIBILITY BETWEEN ARCHITECT-ENGINEERS FIRST DECIDED AMONG THEMSELVES

Captain ALBERS. At the start we left it up to the joint venture. They elected to keep one firm in New York and one in Boston. Some of our joint ventures establish a separate office where it is all one group. These two firms elected to keep their respective offices in their home town. It became obvious that we were going to have to expedite the work, and in view of Moran-Proctor's experience in heavy marine structures, I felt that it was necessary that they do that part of the work.

FURTHER DEFINITION OF SUPERSTRUCTURE

Now, there was a little confusion this morning on the actual division. To me, the structure starts down in the botton of the ground and comes up the leg, through the braces, and in actuality this part of the platform [referring to the model] along the edge is a large box girder, which is in reality a part of the structure frame.

It was that portion of the work which all works together as a unit. Wave forces and wind forces cause stresses in all of these members, and it was necessary that that all be done by one firm.

The superstructure, as I possibly used the term, does not appear on this [referring to model]—yes; it does; the superstructure is the part above the platform.

Senator SALTONSTALL. Above which platform?

Captain ALBERS. This one [referring to model].

It sticks up, it is a deckhouse that we have referred to.

Senator SALTONSTALL. Now, if you will take that platform off the model, that comes off, I believe, what part of the work did the Anderson firm have to do, above or within that platform?

Captain ALBERS. They did the arrangement of the machinery, the living quarters, the power for the radar equipment, and so forth, within this triangular portion of the platform.

In addition, there is a deckhouse where all of the equipment is placed. It is a little difficult for me to show on this model. But it is above this triangular deck here where all of the radar equipment is placed and is operated.

And that was the portion of Anderson-Nichols' work.

Senator SALTONSTALL. And you approved of these designs?

Captain ALBERS. Yes, sir.

Senator SALTONSTALL. Was this a negotiated agreement with the Anderson firm originally?

Captain ALBERS. Yes, sir.

Senator SALTONSTALL. Then you say that after they had made the designs you put it out to competitive bids?

Captain ALBERS. For the construction; yes, sir.

Senator SALTONSTALL. And those were open competitive bids?

Captain ALBERS. Yes, sir.

Senator SALTONSTALL. Advertised with all the procedure that goes with it?

Captain ALBERS. Yes, sir.

Senator SALTONSTALL. Who awarded those contracts?

Captain ALBERS. The award was made by the Bureau of Yards and Docks, sir.

Senator SALTONSTALL. You were not personally responsible for the awards?

Captain ALBERS. No, sir. I was responsible for the taking and the receiving of the bids, however, sir.

Senator SALTONSTALL. Who was responsible to see that the contractors did their work well?

Captain ALBERS. That was my responsibility, or the responsibility of the officer in charge of construction.

Senator SALTONSTALL. Now, Mr. Anderson testified this morning that his firm did not go down there to see if the work was being properly done.

Do you agree with that testimony?

NAVY HAD RESPONSIBILITY FOR QUALITY CONTROL

Captain ALBERS. That is correct, sir. It is customary for us in the Navy to have resident officers in charge with an inspection staff to see that the contract is completed as designed.

Senator SALTONSTALL. And that was done in this instance?

Captain ALBERS. I presume so. I was not there for the construction of this particular Texas tower No. 4 after it was started.

Senator SALTONSTALL. What was your change in assignment?

Captain ALBERS. The staff of the commander of the Striking Force, Southern Europe, in Naples.

Senator SALTONSTALL. I didn't get that.

Captain ALBERS. Commander, Striking Force, Southern Europe, in Naples.

Senator SALTONSTALL. So before this tower No. 4 was constructed, you were out of Boston?

Captain ALBERS. That is correct, sir.

Senator SALTONSTALL. Who took your place?

Captain ALBERS. A Commander Foster.

Senator SALTONSTALL. And he was responsible, then, for the construction of Texas tower No. 4?

Captain ALBERS. That is correct, sir.

Senator SALTONSTALL. And is Commander Foster here?

Captain ALBERS. No, sir. I understand he is in Guam, sir.

Mr. KENDALL. We will have him at a later date, Mr. Chairman.

Senator SALTONSTALL. Now, Counsel, unless you want to change your plans and ask questions, we will see the movie. I suggest we proceed with the movie.

Mr. KENDALL. Before they start the movie, let me ask you this question: Did the Air Force have any responsibility for the construction of either the superstructure or the structure supports?

Captain ALBERS. That was a Navy responsibility.

I was quoted in the morning testimony as saying the Air Force was responsible for the superstructure. The Air Force was the customer, and they were quite interested in, and had a right to be, in the layout of the facility insofar as location of living facilities, messing facilities, the amount of power, and the utilities required for their radar, and so forth.

And they were consulted frequently on that phase of the work, much as an architect would consult with the owner of a house which he has built.

Senator SALTONSTALL. When did you turn Texas tower No. 4 over to the Air Force, if you know?

Captain ALBERS. That was after my time, sir. I understand it was in November of 1957.

Senator SALTONSTALL. Was there any understanding while you were in Boston of who was to maintain these towers?

Captain ALBERS. Could I answer that with respect to the towers that I did build, sir?

Texas towers 2 and 3 we did build under this same type of arrangement. They were accepted by the Air Force upon their completion, and it was their understanding, to the best of my knowledge, that they would maintain them.

However, we, on a number of occasions, did continue to help them with it in the procurement of materials, and so forth.

Senator SALTONSTALL. So that the Navy, after it was turned over to the Air Force and accepted by the Air Force, had no further responsibility unless they were called upon by the Air Force?

Captain ALBERS. That is my understanding, sir.

Senator SALTONSTALL. Thank you, sir.

Now, we will see the movie.

(A motion-picture film on the construction of Texas tower No. 4 was then shown. Included here is the commentary accompanying the film:)

Commentary: In November of 1955 a contract for construction of two Texas towers known as TT–3 and TT–4 was awarded to a joint venture made up of J. Rich Steers and Morrison-Knudsen, Inc., the low bidder.

The first one was constructed some 65 miles southeast of Nantucket in 80 feet of water.

The second one, known as Texas tower No. 4, the construction of which you will now witness, was constructed some 85 miles east of the New Jersey coast in 185 feet of water.

Both towers were fabricated and assembled in a shipyard in Portland, Maine.

The platform, which you see in this view, is triangular in shape, some 200 feet on the side, and 20 feet high.

It weighed approximately 3,600 tons.

This platform had already been assembled in a drydock, floated, and towed to this fitting out pier.

You will notice some 600 tons of construction equipment being put aboard to use on the construction site.

Due to the excess of depth of water at the location of the tower it was necessary to construct the legs, which we call the template, separate from the platform. These legs were laterally braced and floated out as a separate unit. They were assembled, as you see here, in a graving dock, each leg 310 feet long, 12½ feet in diameter, and 450 tons in weight.

On the upper end of each leg was installed a jacking tower which supported the cables on which the platform was later jacked up.

At the bottom of these legs was constructed a caisson 25 feet in diameter and 20 feet in height. You can see here the construction of the jetting system which was installed to facilitate the sinking of these caissons into the ocean floor.

In order to erect the one leg known as the "C" leg, some 135 feet in the air, it was necessary to erect four guide derricks which you see are being erected at this time in another graving dock.

After the three legs were completely assembled in the one graving dock, the dock was flooded and the legs floated into an adjacent dock in which the guide derricks had previously been assembled, the "C" leg being positioned between the guide derricks.

After positioning, the leg was raised from 6 feet above the water surface and held there while the other two legs were brought into position and the struts connected between them.

The struts used to connect the legs were 24 and 30 inches in diameter, except for the one at the lower end, which was used as a buoyancy strut, and was 6 feet in diameter.

Senator SALTONSTALL. Mr. Chairman, without stopping the movie, couldn't somebody be there to point out these things on this model when they are mentioned?

Captain ALBERS. May I do that, sir?

Senator STENNIS (now presiding). That would be helpful.

Commentary: In order to erect the leg it was necessary to put a temporary strut in position. This strut was made up of structural shapes, which you can see in the foreground of this picture.

After the two legs were securely fastened, the third leg or "C" leg was then raised to its final height of 135 feet.

At the present time, the buoyancy struts, which were 6 feet in diameter, are being installed.

After the "C" leg was raised to its final position, the struts were then connected between the two lower legs and the "C" leg, making one complete unit some 310 feet long, 155 feet in height, and weighing 1,800 tons.

In order to upend the template on the site it was necessary to install a control platform which hung from one end of the "C" leg.

This platform, which you can see, was 20 feet by 30 feet, and housed the controls necessary to flood the buoyancy compartments.

In order to familiarize ourselves with the action of the template during the upending operations, we made a model to a scale of 1 to 25, and used this to practice with prior to sailing time.

Senator SALTONSTALL. What is making that model float now?

Captain ALBERS. The air in the structural tubes that make up the tower.

Commentary: After months of preparation, the template was finally completed and the tow to the site began.

Since this structure was fabricated in Portland, Me., it was necessary to tow both the template and platform some 350 miles through ocean storms to the site, which took approximately 7 days.

During this tow we had five men aboard the template control platform to assure the security of the template.

Two oceangoing tugs were used to tow the template, as well as two tugs in towing the platform itself.

It must have presented an odd sight for any passing steamship to observe such odd-shaped structures at sea.

In order to facilitate construction, we installed two 3,900 Matador crawler cranes, each with a capacity of 45 tons, as well as the permanent gantry crane, which had a capacity of 25 tons.

Finally, after 7 anxious days of towing through the Atlantic, we arrived at the site some 85 miles due east of the New Jersey coast.

We waited several days for the sea to calm down, and then decided to start operations in upending the template.

We took a day to prepare the template for upending, and set the time early the following morning for the beginning of the actual flooding operations.

Senator SALTONSTALL. Captain, this is the long——

Captain ALBERS. You are looking at the bottom which is fastened down.

Commentary: During upending, finally, when we decided to start the upending operation, the control house is cut loose from its supports and permitted to swing freely.

The first valves were opened at 7 o'clock one morning. The template gradually inclined until the bottom end of the "C" leg finally touched the water some 5 hours later.

During this upending operation, we held the template in position with two towboats.

Just as the "C" leg touched the water, the template rolled to such an extent that it was out of level some 17 degrees.

When this happened we operated the valves in an attempt to level off the template.

After an hour of this controlled flooding, and many anxious moments, the template itself rolled in the other direction almost 17 degrees.

This was certainly a trying time for all of us, particularly the fellows stationed in the control platform.

Senator STENNIS. Where is that control platform, Captain?

Captain ALBERS. Hanging from the top of the template, it is the small structure.

Senator STENNIS. I see.

Commentary: By operating the control valves a little at a time, we were able to get the template under control.

We then opened the proper valves and continued the upending.

It had been arranged previously that the template would be upended so that it would float within a clearance of at least 15 feet above the ocean bottom.

When, after 12 hours of very anxious moments, the template was finally in a vertical position, it was then towed to its exact position and lowered to the ocean floor.

It was required under the contract to position this tower within 200 feet of a point marked by the Navy and within 5 degrees of the proper azimuth.

Actually the template was placed right on the marker buoy, and within one-half of a degree of its described position.

The next morning, after the template had been securely placed on the bottom, the platform was then towed into position.

You see here one of the corners which was provided with a recess into which one of the legs would fit. These recesses were provided with rubber bumpers to absorb some of the shock anticipated by wave action.

In order to jack up the 4,200 tons of platform construction equipment, we installed in each corner eight jacks capable of lifting 187½ tons each. These jacks consisted of an upper and lower gripper joined by a hydraulic cylinder. These grippers were used to grip the cable previously installed on the template and which, in the template's position at this time hung down from the jacking towers.

During the operation of towing the platform between the template, complete radio control was maintained between the plaform and all the posts.

Although from visual observation only 1-foot swells were apparent, when we finally brought the platform into the template it appeared that there were longer swells present which could not have been observed.

The action between the template and the platform indicated a movement of at least 4 feet.

After the platform was in place, gates which were previously provided for were closed around the open end of the recesses, which secured the platform to the legs in a horizontal position, and allowed it to move vertically.

Due to the complexity of the project, we had all the personnel available abroad.

In this scene you see J. Rich Steers, president of J. Rich Steers, Inc., watching the procedure.

This is Dr. Phil Rutledge of Moran, Proctor, Mueser and Rutledge, contractor for the Navy on the work.

The job now was to thread the cables through the grippers in order to start the jacking operation. Because of the movement between the platform and the legs, it was decided to use only half the jacks to raise the platform above the effects of the swells.

The threading operation took approximately 12 hours to perform, and we were all much relieved when we started to raise the platform.

All the hydraulic jacking operations were controlled electrically by the control box shown here.

In order to assure ourselves that the jacking system would work properly, we had the tugboat stand by, as you can see here, while we hooked up the system and started jacking.

This scene shows the tremendous amount of motion we had between the legs and the platform, even though we had a relatively calm sea.

After the platform was raised to 4 feet, thus removing most of the motion, we threaded the cable through the remaining jacks and started to complete the jacking system up to a point where the platform was some 40 feet above the water surface.

The jacking system which we used, provided a 4-foot stroke, and the cycle of each stroke took approximately 20 minutes.

After we raised the platform to this elevation, it became necessary to remove the temporary struts on the control house to provide enough head room for the cranes we had aboard to operate efficiently.

Senator STENNIS. I am sorry, we will have to suspend.

Gentlemen, that is very impressive. But we will have to suspend now due to a vote.

But I certainly want to see all of this.

The committee will stand in recess subject to the call of the Chair.

I expect to come right back.

(Brief recess.)

Senator STENNIS. Proceed with the picture, please. You have about 20 minutes more.

(The commentary continued:)

In order to supply the tower with men and supplies, it was necessary for us to equip an old Coast Guard cutter of some 1,100 tons in weight, which ran between the mainland and the tower. We used a basketlike platform set on a rubber tube which we called a doughnut for hoisting the men from the supply ship to the platform. During rough weather, many personnel had a ride that could not have been duplicated at an amusement park.

We were fortunate in all our operations, loading and unloading the men, not to have injured anyone.

There was one advantage to a job in such a location as this, it makes it easier to dispose of unwanted material. While the platform was in this position, we connected up our airlift system and started excavating. The airlift consisted of a 12-inch pipe some 225 feet in length. In order to sink the caissons, which were 25 feet in diameter and 20 feet in height into the sandy ocean bottom, it was necessary to airlift the three legs practically simultaneously. This was done with 2,000 cubic feet of air. The caissons were sunk in approximately 18 hours. It was not until then that we felt we were secure from any storms except those of hurricane magnitude.

After this operation was completed, the platform was raised 65 feet above the water. The three bottom caissons were completely filled with concrete and lined with concrete from an elevation of minus 50 to the top of the platform. This left each leg with an opening of 8 feet in diameter, which was used to store fuel oil later on.

After the concrete operation was completed and the platform welded onto the leg, the jettying system was disassembled, the leg then cut flush with the deck, and the openings covered over.

Now, here are operations that were due to storms that we encountered. We lost two of the permanent braces. These had to be replaced. In this scene, you see one of the braces being lowered into position for installation by the divers. During the construction of the tower, we had many rough seas, and the bringing in of supplies and equipment to the tower was quite a problem. We used large barges to supply the permanent materials, which you can see here.

Senator STENNIS. Suspend for a moment. Senator Saltonstall is compelled to leave on another official mission. The Senator wishes to ask a few questions.

Senator SALTONSTALL. Mr. Chairman, thank you very much.

Captain, I am sorry I cannot stay. I would like to ask this question of you:

Why did you have to make this Texas tower No. 4, different in its construction from the other two? I realize that you drove it down into the sand. When you got it into the sand, why was it necessary to have it different?

DEPTH OF WATER REQUIRED DIFFERENT CONSTRUCTION

Captain ALBERS. Because of the extreme depth of the water, Senator. This was in 180 feet of water. The others were in 55 and 85 feet of water, respectively.

The water depth at the site of this tower is quite different, and these legs are quite long. They are 250 feet long from here to the ground [indicating], and needed some support laterally.

Senator SALTONSTALL. Did you consider, in approving of this particular design, the question of the additional stress on the three legs of these braces that you put in between?

Captain ALBERS. Yes, sir.

Senator SALTONSTALL. When you say "Yes, sir," would you give the reason?

Captain ALBERS. If I understood the question, Senator, did we consider the pressure of the water on the braces as they affected the tower? Was that the question?

Senator SALTONSTALL. Yes. I know the tide does not run very high out there, but there is a certain amount of water pressure all the time on those braces. Of course, when there is a sea running or a high wind, there must be a tremendous amount of additional pressure on those braces.

Captain ALBERS. That was considered, sir. The tide there is about 4 knots. Most of the wave action, however, is above the elevation of the braces. That is why they were placed below water and none above water.

Senator SALTONSTALL. Did the Navy make any underwater inspection after these legs were in place and if so, how many?

Captain ALBERS. Senator, I am not in a position to answer that. I was not out there, sir.

Senator SALTONSTALL. Who will be in a position to answer? Commander Foster?

Captain ALBERS. Commander Foster. I was detached and out of the country by that time.

Senator SALTONSTALL. You take responsibility for the design?

Captain ALBERS. Yes, sir.

Senator SALTONSTALL. And in your opinion, as an engineer of the Navy, you determined that that design could stand the stresses and strains of a heavy storm in that location?

Captain ALBERS. Yes, sir.

Senator SALTONSTALL. You believed it could?

Captain ALBERS. I believed it could, sir.

Senator SALTONSTALL. Thank you, Mr. Chairman.

Senator STENNIS. Thank you, sir. Captain, I would like to know just what you mean when you say you take the responsibility for the design? Are you an engineer?

Captain ALBERS. Yes, sir.

ASSUMPTION OF DESIGN RESPONSIBILITY

Senator Stennis. In your professional capacity, could you have designed such a structure yourself?

Captain Albers. That would be rather difficult. I have not been following detailed design work throughout my Navy career. I am quite familiar with design work.

Senator Stennis. Well, of course, you have many other things to do. If you were not prepared to design the tower yourself, though, I do not see how you can say that you were responsible for the design, unless you are just saying that you were the officer who was in charge at that stage, and in your opinion as a naval officer, it was your responsibility.

Now, are you saying it in that capacity or as an engineer?

Captain Albers. I say it in the capacity of an engineer, Mr. Chairman. We spend all of our time in engineering work, both design and construction, and I am familiar with design procedures, and I know that the correct design procedures were followed in the design of this tower.

Senator Stennis. I do not see how you could say that it was your responsibility, and that you were responsible for the design, unless it was just a command proposition.

Captain Albers. Well, Mr. Chairman, I do not know what to say, except that I felt that I was responsible for the proper design of these towers, and I had assistance from the civilian design members of the District Public Works Office, who were prepared to and did, in a number of cases, check these computations, sir.

Senator Stennis. Well, I admire your spirit about it in being willing to assume the responsibility as a naval officer. But just to say that you were responsible for it and put a period there, why, I think that further inquiry than that is essential for us to carry out our obligations.

Captain Albers. I am a graduate engineer and a licensed engineer, sir.

Senator Stennis. I was crediting your qualifications, rather than discrediting them. As I say, I commend you for being willing to assume the responsibility.

All right, you may proceed, Captain, in your own way.

Captain Albers. Do you want to continue with the movie sir?

Senator Stennis. Yes, with the film.

(The commentary continued:)

Having to keep clear of the two corners because of interference with the leg during the installation of the tower, it was necessary to install at sea that portion of the deckhouse which extended over these two corners. The deckhouse, which overhangs two of the corners and consisted of approximately 300 tons of steel, was to be used by the Air Force for housing their radio and their radar equipment.

This deckhouse projected 15 feet above the main deck and provided foundations for the Arctic tower and radar domes installed later on.

After the deckhouse was completed, the Arctic tower was then erected. This was fully insulated and provided with heat and air conditioning, to provide the proper atmosphere for the radar equipment installed later on by the Air Force.

After completion of most of the heavy lifts, we disassembled the two crawler cranes we had on deck and lowered them over the side to a waiting scow. We then used the permanent Gantry cranes for all future operations.

This scene shows some of the exhausts hooked up to the machinery installed inside the platform. Beside the installation of the deckhouse and Arctic tower, it was necessary to install tropodisc radio antennas and the like. Due to the length of the legs, which were from the ocean bottom some 285 feet in length, the equivalent of a 28-story building, there was considerable motion, as you can see in this picture, even after the platform was securely fastened to the legs.

Inside the platform, living space was provided for 75 enlisted personnel and 8 officers, complete with a galley and a messhall.

We also equipped a room as a sick bay to take care of the men permanently assigned.

While all the exterior work was going on, there was a tremendous amount of work in progress in the platform itself. It was necessary, besides fixing up these rooms that you are now witnessing, to hook up the seven 250-kilowatt permanent diesel engine generators, as well as the evaporators, the portable steam, lighting, heating system, and other mechanical equipment necessary to maintain a platform of this size.

The messhall was used not only for eating, but for recreation of the men, and contained a television set which picked up many programs from shore.

The final day arrived, and the Air Force came in on a helicopter to take over the platform. During construction, it was impossible for us to use the facilities of the helicopter, due to the fact that the main deck was used for storage space for supply and equipment.

After the Air Force left personnel to operate the tower, our men were then loaded aboard the supply ship for the last time and taken ashore. After 4 months from the time we sailed from Portland, Maine, we left the tower in the hands of the Air Force, who had the job of installing the radio and radar equipment.

Finally, after 2 years, and many hours of engineering and planning, we left Texas tower No. 4, the second of two Texas towers which we constructed, with a feeling of pride in having accomplished something that was unique in itself, and the first of its kind constructed in the world.

The picture which you have just witnessed shows some of the many extraordinarily difficult engineering and construction problems which confronted us during the erection of this tower. Perhaps the first challenge and critical problem we were faced with during the construction was the upending of the tower. It is important to know that never before this time had a similar operation been attempted, much less completed. One important thing was to pick a time of the year in which we could be relatively sure of a fairly calm sea, in order to erect the tower before the advent of the hurricane season.

In the North Atlantic, hurricanes are prevalent from the first part of August, through December. It was necessary to implant these towers, to complete the concreting of the legs, and weld up the platform to the legs prior to the passing of any hurricane. You can well imagine that most of our personnel became weather experts during the construction. In fact, in the case of Texas tower No. 3, a hurricane passed within 100 miles of the construction site only 7 days after we arrived.

Undoubtedly, we were very lucky in this instance, because if this hurricane had changed its course a degree or two to the west, it would have completely destroyed that tower.

In addition to their location, many problems, such as mooring barges in heavy seas, loading and unloading supplies, equipment, and personnel in dense fog, wind, and tide, presented a never-ending challenge. All these problems were met by a combination of engineering and construction know-how, so that today, Texas towers 3 and 4 stand as a vital part of the early warning radar defense of the United States, prepared to give early warnings in case of any enemy attack. [End of film commentary.]

Senator STENNIS. All right, gentlemen. That is a very good presentation. It shows much creditable work on the part of the Navy. The erection of the tower was a tremendous undertaking, as this film shows, more clearly than any testimony, however clear or however eloquent it might be.

70733—61——5

As I understand it, that film was made during the time that the tower was actually being fabricated, put into position, and completed; is that right?

Captain ALBERS. I understand it was, sir.

Senator STENNIS. Well, do you know? Does not someone know?

Mr. EDWARDS. Yes, it was.

Senator STENNIS. The voice was put in later; is that correct?

Captain ALBERS. Put in what part, sir?

Senator STENNIS. The voice or the narration—the sound track, I believe it is called—was inserted later, is that correct?

Captain ALBERS. I am not qualified to answer.

Mr. EDWARDS. This is correct, sir, but it was put in later by the contractor. This film was prepared by the contractor, and he did put the sound track on it later, after he had completed filming the picture.

Senator STENNIS. It was said at the last that all requirements had been met and the tower stands there as a vital part of our radar defense. Of course, a lot has happened since that film was made and that voice spoke. I just want to know when the sound track was put in. Does anybody know that?

Mr. EDWARDS. We do not have the exact date on that, sir. We can get it for you.

Senator STENNIS. Well, the approximate time.

Captain DAVIS. We shall attempt to find out, sir. I do not believe we know.

Senator STENNIS. Can you say it was narrated soon after the film was made?

Mr. EDWARDS. It was some time after, because I remember showing the film without the voice to a group in the Pentagon shortly after it was built, and it was some time after that that the voice was added. Probably 6 months, I would guess.

Senator STENNIS. Gentlemen, I had not understood in the beginning why it was considered better to have a tower than it was to have a picket ship out on duty. I think perhaps the Air Force is better able to testify on that than the Navy.

Captain, what was your understanding of that situation? Why would a tower serve better than a ship?

Captain ALBERS. I was told that the tower would serve better because it would be in a set location at all times, that it was relatively stable and could be used to transmit communications back to the mainland automatically.

Senator STENNIS. Could not a ship serve the same purpose?

Captain ALBERS. I am not qualified to answer that, sir. We did not install the radar equipment.

Senator STENNIS. Isn't the Navy very familiar with radar? Doesn't it use radar all the time?

Captain ALBERS. Yes, sir, but not in the Civil Engineer Corps. I am a civil engineer, sir.

Senator STENNIS. But you have gentlemen in the Navy who can testify on this, I am sure.

Captain ALBERS. Yes, sir.

Senator STENNIS. Is there anybody present from the Navy who is qualified to testify in that category?

Rear Admiral CHURCH. No, sir.

Senator STENNIS. Do you have any disposition to supply us with a witness who can testify?

Rear Admiral CHURCH. I shall be very happy to, sir.

Senator STENNIS. Make a note of that, Mr. Kendall, because I think it is something we ought to look into.

I remember several years ago hearing testimony to the effect that there were ships out there filling a role of this kind. I am not going to ask if they are still there, because that would perhaps be a classified question and we would have to go into closed session. But I do know that ships were being used for this purpose.

Captain ALBERS. The difference, I believe, Senator, is that ships are not able to transmit the information automatically back into the SAGE system.

Senator STENNIS. Well, we would like you to give us someone from the Navy who specializes in that field and can give us the technical answers.

Someone suggested to me that a ship would not be suitable because it is not stationary. However, I noticed that the tower, before they started using it, had some motion. That is correct, is it not? This appears from the picture that was shown, and the narration states that.

Captain ALBERS. Yes, sir.

Senator STENNIS. And as time went on, the testimony shows, I believe, that there was considerable motion following these dislocations and the braces being broken.

Mr. Counsel, you proceed, please.

Mr. KENDALL. Captain Albers, I believe you stated in your opening statement that the wave and wind criteria and design procedures were approved by the Air Force?

Captain ALBERS. Yes, sir.

Mr. KENDALL. Is there not apparent conflict in that statement with Dr. Charyk's testimony this morning, when he said that was entirely the Navy's responsibility?

Captain ALBERS. Yes, sir, it was the Navy's responsibility. However, as I tried to explain, the Air Force accepted our feasibility report, which included these wave and wind criteria, and I considered that as approval for my statement.

Mr. KENDALL. At what stage of the construction of Texas tower No. 4 did your connection with the program terminate?

Captain ALBERS. The tower at that stage was partially prefabricated in the dry dock.

Mr. KENDALL. Who was your successor?

Captain ALBERS. Commander Foster.

Mr. KENDALL. Where is he located now?

Captain ALBERS. I understand he is located in Guam now.

SELECTION OF ARCHITECT ENGINEERS FOR TEXAS TOWERS PROJECT

Mr. KENDALL. Do you have a copy of the memorandum of the meeting of the selection board of April 9, 1954?

Captain ALBERS. It is available, sir.

Mr. KENDALL. Will you make that a part of the record, please, sir?

Captain ALBERS. Yes.

(The document referred to is as follows:)

MARCH 23, 1954.

From: District Public Works Officer, 1st Naval District.
To: Chief, Bureau of Yards and Docks—Code C–270A.
Subj.: Dept. of the Air Force Project "Texas Towers."
Ref: (*a*) DPWO setltr DS–300 RSS: mg Ser 00331–DPWO of 11 Mar 1954 to BuDocks.
(*b*) Telecon, Code C–110 to Asst. DPWO 1ND, 18 Mar 1954.

1. Reference (*a*) submitted the following list of contractors considered qualified to handle subject project:

Anderson-Nicholson & Co., Boston, Mass.
Fay, Spofford & Thorndike, Boston, Mass.
Chas. T. Main, Inc., Boston, Mass.

Since Chas. T. Main has been selected to handle Advance Planning in connection with the Second Increment of Improvements to the Power Plant, Boston Naval Shipyard, this firm is being removed from the list.

2. In accordance with reference (*b*) additional firms as follows will be considered:

Frederic R. Morris, Inc., New York, N.Y.
Merritt-Chapman & Scott Corp., New York, N.Y.
Gilbey and O'Malley, Philadelphia, Pa. (associated with Raymond Concrete Pile Co.).
J. E. Greiner Co., Baltimore, Md.
DeLong Engineering & Construction Co., New York, N.Y.

WM. F. WESANEN.

MEMORANDUM

APRIL 9, 1954.

To: D–10.
Subj: Minutes of A&E Selection Board meeting held 9 April 1954, Dept. of the Air Force Project "Texas Towers."
Ref: (*a*) DPWO Order Ec. 5/51 of 9 April 1951. [Sic 1954.]
(*b*) DPWO ltr DB–300 RSS:mg 14–3 of 23 Mar 54 to BuDocks.
(*c*) BuDocks SECRET ltr C–270A/GCE:vfp N11 Y&D ser 007016 of 19 Mar 54 to DPWO 1ND.
(*d*) Massachusetts Institute of Technology—Lincoln Laboratory—Preliminary Report on "Texas Towers."

1. By paragraph 2 of reference (*c*) the District Public Works Officer was authorized to interview A & E firms regarding advance planning and/or design of subject facilities.

2. By reference (*b*) the Bureau of Yards and Docks was advised of the list of contractors to be considered.

3. Representatives of the contractors have been interviewed as follows:

Firm	*Representatives*
Anderson-Nichols & Co., 150 Causeway St., Boston 14, Mass. and Moran, Proctor, Mueser & Rutledge, 420 Lexington Ave., New York 17, N.Y.	Mr. E. Ross Anderson. Mr. William F. Dewey. Mr. John Minnich. Mr. Vincent K. Cotes.
DeLong Corp., 29 Broadway, New York 6, N.Y.	Mr. George F. Tait. Mr. C. E. Suderow.
Fay, Sofford & Thorndike, 11 Beacon St., Boston 6, Mass.	Mr. John Ayer. Mr. Frank L. Lincoln.
Gilbey & O'Malley, Maers Bldg., Scranton, Pa. and	Mr. E. Lawrence Bellante. Mr. Danny Thompson.
Raymond Concrete Pile Co., 140 Cedar St., New York 6, N.Y.	Adm. Kirby Smith. Mr. W. P. Kinneman.
Frederic R. Harris, Inc., 27 William St., New York 5, N.Y.	Mr. G. J. Murphy. Mr. W. Squire.
Merritt-Chapman & Scott Corp., 260 Madison Ave., New York 16, N.Y.	Mr. J. Peraino.
Frederick Snare Corp., 233 Broadway, New York 7, N.Y.	Mr. Harold S. Dell.

4. As a result of interviews with the above, it has been determined that Merritt-Chapman & Scott Corp., DeLong Corp., and Frederick Snare Corp. are either interested in the construction contract or decided on the type of design that should be followed on this project.

5. Due to the wide range of thought and conflicting ideas it was concluded that an A. & E. should be selected to evaluate existing designs of similar types of structures and modify those designs to suit the criteria, consequent layout of the platforms, and field conditions of the location of each tower.

It was further agreed to select the firm who can approach the problems of offshore platform construction with a clear and unbiased mind and without a vested interest in any existing or patented feature of such construction. It is understood that the duty of the firm will be to evaluate all existing systems and ideas for construction of offshore platforms while preparing a standard specification and schematic drawings setting forth design requirements, basic conditions anticipated, space and service requirements for equipment and personnel, and an estimate based upon a feasible construction concept. It is known that several firms have built or have designed offshore platforms, most of them in connection with oil drilling platforms in the Gulf. Several of these firms have patented features which they may be reluctant to release to competitors in the field. It is presumed that the firm recommended will find some merit in the features of any given design and may well find the construction of such platforms is a reasonably competitive project. Because several of the firms who are capable of building such projects have pet or patented features, it is considered that each will bid competitively only if his features can be employed in the project. If final design is based upon the features of any particular firm, it is likely that those firms whose features are not included or cannot be adopted will consider themselves excluded from the bidding or they will be forced to bid on the basis of an alternate design of their own. It appears to this Board that the best way to get these projects underway on a competitive basis is to take bids for final design and construction. This will permit any firm or combination of firms who have a pet or patented idea to bid competitively and will assure complete responsibility for design and construction and will most effectively close the gap between design responsibility and construction responsibility. Inasmuch as these offshore platforms represent an advance in the state of the art and will probably require both engineering and construction pioneering, the separation of design from construction will establish a divided responsibility which ought not and need not be accepted in this case. Inasmuch as these projects are reasonably spectacular, award in this manner should provoke competition from large engineering and construction firms on a nationwide basis. It should bring the best engineering brains to bear on the subject.

6. After careful consideration of the capabilities, personnel, and liaison difficulties created by the locality of the A & E design office, the Board recommends the selection of Anderson-Nichols & Co., and Moran, Proctor, Mueser & Rutledge.

7. The fee for the work will be negotiated after the A & E selection.

MEMBERS OF BOARD

Comdr. J. J. ALBERS,
Comdr. F. L. BIGGS,
Lt. J. LAPORTE,
D. Y. TAYLOR,
S. S. SWINDELLS (Recorder),

Approved.

WM. F. WESANEN,
Captain (CEC) USN.

Mr. KENDALL. Captain Albers, what was the reason for the elimination of Merritt-Chapman & Scott, DeLong Corp., and Frederick Snare Corp. from consideration as the design engineers on this project?

Captain ALBERS. We considered that the joint venture of the two firms that we selected was more capable of accomplishing the work, plus the fact that one member of that joint venture was in the immediate geographical area of the 1st Naval District.

Mr. KENDALL. As a matter of fact, is it not true that you did not even get to the stage of giving any consideration to DeLong, and Merritt-Chapman & Scott, and Frederick Snare; that you eliminated them immediately?

Captain ALBERS. May I see the report?

Of course, those corporations are basically construction outfits, rather than design outfits. They were permitted to bid on the construction.

Mr. KENDALL. But they were eliminated from design consideration, were they not, Captain?

Captain ALBERS. That is correct—wait just a minute.

No, we interviewed them, sir.

Mr. KENDALL. The memorandum states that they were eliminated, does it not, because they were either interested in the construction or that they had decided on a type of design that should be followed?

Captain ALBERS. Yes; but we did consider them, sir. You said "eliminated" them from consideration. But we thought the two firms selected were in the best position.

Mr. KENDALL. They had been eliminated prior to the time of the meeting; is that right?

Captain ALBERS. At the meetings of this board, it was a part of the board's business to discuss this. They were all interviewed and it was the opinion of the board that the two that we selected were the most suitable for this design work.

Now, then, we, as a general rule, do not buy package deals in Navy construction; that is, buy, procure, a firm to do both design and construction.

Mr. KENDALL. Well, these three firms that we mentioned are all outstanding in this particular field, are they not?

Captain ALBERS. They are all outstanding contractors; yes, sir.

Mr. KENDALL. Did any of them submit suggested designs for your board's consideration?

Captain ALBERS. Yes, sir; I think they did.

Mr. KENDALL. Which ones did that?

Captain ALBERS. I am relying on memory now. I think DeLong Corp. probably did. DeLong Corp. and the Frederick Snare Corp.

Mr. KENDALL. They both submitted suggested designs?

Captain ALBERS. Yes, sir.

Mr. KENDALL. Which were considered by the selection board?

Captain ALBERS. Yes, sir.

Mr. KENDALL. Now, I take it that Mr. Anderson was correct this morning when he stated that he was initially contacted by the Navy and that he brought the other firm into the picture?

Captain ALBERS. That, I believe, is true. However, they appeared before the board as a joint venture.

Mr. KENDALL. Does not your memorandum suggest that Moran, Proctor did not have a representative at that board?

Captain ALBERS. My memorandum does so indicate, but it is my remembrance of the subject that Mr. Carleton Proctor attended the board meeting.

Mr. KENDALL. But that is not shown on your memorandum?

Captain ALBERS. That is correct, sir.

Mr. KENDALL. At that time, was there any understanding or agreement of the division of responsibility between Anderson-Nichols and Moran, Proctor?

Captain ALBERS. No, sir.

Mr. KENDALL. When was such an understanding reached, and what were the circumstances of it?

DIVISION OF RESPONSIBILITY BETWEEN ARCHITECT-ENGINEERS

Captain ALBERS. It was the opinion of the board and the district public works officer at the time that we made this selection that Moran, Proctor, due to their experience, would take over the heavy construction portion, and that Anderson-Nichols would take over the equipment layout and the machinery layout and so forth, as was actually the case.

Mr. KENDALL. Was that your understanding, or was it an understanding between the Navy and these two firms?

Captain ALBERS. It was the understanding of the Navy, not necessarily between the Navy and the two firms.

Mr. KENDALL. Well, at what stage was that proposition specified for these two firms and by whom?

NAVY SPECIFIES DIVISION OF RESPONSIBILITY BETWEEN ARCHITECT-ENGINEERS

Captain ALBERS. It was specified by me sometime after the contract was awarded.

Mr. KENDALL. What was the reason for that?

Captain ALBERS. I felt it essential that the whole tower, its foundation, its braces, and the members of the platform which form a part of the main structure, all be designed by one organization.

Mr. KENDALL. Why was it not proper to let them work out that problem within their own organizations, as they had up to that time?

Captain ALBERS. We wanted to utilize the experience of Moran, Proctor in the design of heavy marine structures.

BIDDING FOR CONSTRUCTION OF TOWERS NO. 1, NO. 3, AND NO. 4

Mr. KENDALL. Now, I believe that bids were received for Texas towers 1, 3, and 4 all at the same time; is that correct?

Captain ALBERS. Bids were received as a lump sum for each one of the towers, and in combinations; yes, sir.

Mr. KENDALL. And those bids were based on the designs and plans and specifications prepared by Moran, Proctor?

Captain ALBERS. That is correct.

Mr. KENDALL. Now, prior to the receipt of bids, did you have any discussions with any of the representatives of the DeLong Corp. about the design and proposed construction process?

Captain ALBERS. Yes, sir.

DE LONG CORP. PROPOSES ALTERNATE METHOD

Mr. KENDALL. Was it indicated to you that if DeLong was the successful bidder, they would submit and recommend an entirely different method of construction and erection of Texas tower 4?

Captain ALBERS. It was indicated to me that, if they were the successful bidder, they would offer a substitute method of erection.

Mr. KENDALL. Was the gentleman that you had these discussions with Mr. Suderow?

Captain ALBERS. I think perhaps it was; I cannot remember. I had many discussions with several members of the firm.

Mr. KENDALL. Let me ask you this. Was there any understanding with you or any other officer or, as far as you know, any representative of the architects and engineers in advance of the bidding, that, if Delong was a successful bidder, the method he would recommend would be accepted and permitted?

Captain ALBERS. No, sir.

Mr. KENDALL. You know of no such understanding?

Captain ALBERS. That is correct.

Mr. KENDALL. But there was discussion of this?

Captain ALBERS. Yes, sir, we discussed the pros and cons and various and sundry ways of erecting this.

DE LONG CORP. OBJECTS TO DESIGN AND METHOD OF ERECTION OF TOWER NO. 4

Mr. KENDALL. It is true that Delong or his representative voiced very strong objections to the method of design and method of construction and erection?

Captain ALBERS. That is true.

Mr. KENDALL. And it is true that Delong was in this field longer than any of the others, and was probably the first builder of a Texas tower?

Captain ALBERS. In the field of Texas towers, his firm, together with Raymond Concrete Pile Co., had erected the only Texas tower.

Mr. KENDALL. Actually, Delong also built Texas tower No. 2; did he not?

Captain ALBERS. Yes, sir.

Mr. KENDALL. Was that a bid proposition or a negotiated contract?

Captain ALBERS. Negotiated contract, sir.

Mr. KENDALL. Would not it be fair to say, Captain, that if DeLong had been a successful bidder, this method of construction and erection would not have been utilized on Texas tower No. 4?

Captain ALBERS. I do not think I can agree with that, sir.

Mr. KENDALL. Well, do you disagree with it?

Captain ALBERS. I disagree with it.

MR. THEODORE KUSS EMPLOYED BY DESIGN ENGINEERS

Mr. KENDALL. When and how did Mr. Theodore Kuss get in the picture as an employee of the Moran, Proctor firm?

Captain ALBERS. He first became associated with them about March of 1956.

Mr. KENDALL. Had you known him prior to that time?

Captain ALBERS. I had known him 20 years before, yes, sir.

Mr. KENDALL. Had you known him during the intervening years, or was 20 years before the last time you had had any acquaintance with him?

Captain ALBERS. With the exception of a few days previous to his employment, when he stopped at my office to visit, I had not seen him for quite a number of years, approaching 20.

Mr. KENDALL. Did you have any part in putting him in touch with Moran, Proctor?

Captain ALBERS. No, sir.

Mr. KENDALL. What was his connection with Texas towers, generally? What was his responsibility?

Captain ALBERS. He played a very responsible part in the selection of design of Texas tower No. 4, which was constructed using his patent, which was made available to the Navy at no cost.

KUSS PATENTED METHOD OF ERECTION

Mr. KENDALL. And that is this tipover method that we have seen in the film?

Captain ALBERS. That is correct, sir.

Mr. KENDALL. Do you know whether or not this particular tipover method, or Kuss method, had ever been used before or after in the construction of an off-shore open-sea platform?

Captain ALBERS. I do not think it has been used before or since.

Mr. KENDALL. Now, you had the responsibility, I believe, for the adoption and approval of this particular plan, is that right?

Captain ALBERS. That is correct, sir.

KUSS METHOD NOT CONSIDERED PRIOR TO EMPLOYMENT

Mr. KENDALL. Had there been any consideration of the use of the Kuss method prior to Kuss' employment by the Moran, Proctor firm?

Captain ALBERS. No, sir.

Senator STENNIS. What was your answer?

Captain ALBERS. No, sir.

Mr. KENDALL. At what point in time was the decision made to use the Kuss method?

Captain ALBERS. Shortly after his becoming associated with Moran, Proctor.

Mr. KENDALL. This was after the feasibility report was filed and approved?

Captain ALBERS. That is correct, sir.

Mr. KENDALL. Was it during the preparation of the preliminary plans?

Captain ALBERS. It was during the design stages for Texas tower No. 4.

Mr. KENDALL. Do you have a copy of the bid tabulations for Texas towers Nos. 1, 3, and 4?

Captain ALBERS. There is one available, I believe—just a minute. Yes, we have a copy.

Mr. KENDALL. Would you make it a part of the record, please, sir?

Captain ALBERS. Yes, sir.

(The document referred to is as follows:)

Tabulation of bidding, Texas towers (TT-1, TT-3, TT-4)

Bidders	TT-4, item 1	TT-3, item 2	TT-1, item 3	TT-4 and 3, item 4	TT-4 and 1, item 5	TT-3 and 1, item 6	TT-4, 3, and 1, item 7
J. Rich Steers, Inc. and Morrison-Knudsen, Inc.	[1] $8,639,000	$8,409,000	$7,878,000	$16,431,000	$15,902,000	$15,692,000	$23,356,000
Raymond Concrete Pile Co. and DeLong Corp.	9,908,320	8,017,000	7,436,000	16,890,151	16,523,867	[1] 14,269,047	23,755,614
Merritt-Chapman & Scott Corp.	[2]	11,561,651	8,473,562	[2]	[2]	[2]	[2]

[1] Low combination—Items 1 and 6:

Raymond Concrete Pile Co. and DeLong Corp. (Item 6)	$14,269,047
J. Rich Steers and Morrison-Knudsen (Item 1)	8,639,000
Total	22,908,047

[2] No bid.

Mr. KENDALL. Under the bidding process there, I believe, it was so arranged that the contractors could bid in a number of different ways, so they could bid on each tower separately or on any combination of all the towers?

Captain ALBERS. That is correct.

Mr. KENDALL. I believe when you opened the bids, you found that DeLong and Raymond, as a joint venture, were low on all the towers individually, except tower No. 4, and all combinations of towers except combinations where Texas tower No. 4 was concerned?

Captain ALBERS. That is right.

Mr. KENDALL. Conversely, they were higher than the low bidder on Texas tower No. 4 or any combination involving Texas tower No. 4?

Captain ALBERS. That is correct.

Mr. KENDALL. If the award had been made as bid, I believe that Steers and Morrison-Knudsen, as a joint venture, would have gotten Texas tower No. 4 and DeLong-Raymond, as a joint venture, would have gotten Texas towers No. 1 and No. 3, is that right?

Captain ALBERS. That was my recommendation after the opening of the bids.

Mr. KENDALL. Do you have a copy of that recommendation with you, Captain?

Captain ALBERS. I do not have it with me, I do not think.

It can be made available, sir. I do not have it with me.

Mr. KENDALL. Is this a copy?

Captain ALBERS. It looks like it.

Mr. KENDALL. Let us make it part of the record, if you can identify it.

Captain ALBERS. This is a copy of my message.

Senator STENNIS. Let that be admitted in the record.

(The document referred to is as follows:)

BEB–B359
MM RDEPC
DE RBEBC 52
M O12140Z
7M OINCC Texas Towers BSN.
TO BUDOCKS.
Info AF installations Rep Office New England RGN BSN.
BT

Bid results Texas towers contract NOY-88202 received today:

Contractors	TT-4, item 1	TT-3, item 2	TT-1, item 3	TT-4 and 3, item 4	TT-4 and 1, item 5	TT-3 and 1, item 6	TT-4, 3, and 1, item 7
Merritt-Chapman & Scott Corp		$11,561,651	$8,473,562				
Raymond Concrete Pile Co	$9,908,320	8,017,000	7,436,000	$16,890,151	$16,523,867	$14,269,047	$23,755,614
Raymond-DeLong							
J. Rich Steers, Inc	8,639,000	8,409,000	7,878,000	16,431,000	15,902,000	15,692,000	23,356,000
Morrison-Knudsen, Inc							

Lowest combination for 3 towers item 1 of J. Rich Steers & Morrison-Knudson and item 6 of Raymond-DeLong. Request authorization to award on items 1 and 6 and that funds in amount $25,000,000 to provide for award and contingencies be authorized by message with immediate obligation authority X DPWG concurs. X bids provide for award within 20 calendar days.
BT
01/2142Z NOV RBEBC

Mr. KENDALL. When Texas tower 1 was eliminated, it was then that Steers and Morrison-Knudsen were determined to be low on their bid on 3 and 4, is that right?

Captain ALBERS. That is correct, sir.

Mr. KENDALL. That is how the contract was finally awarded?

Captain ALBERS. That is right, sir.

BUREAU OF YARDS AND DOCKS CONCURRED IN DESIGN CRITERIA

Mr. KENDALL. Did the Bureau of Yards and Docks make any study of the oceanographic factors involved; the ocean waves and wind, and so forth?

Captain ALBERS. Could I refer that question to Mr. Ayers, who is a member of the technical staff?

Mr. KENDALL. Yes, certainly.

Mr. AYERS. Yes, the Bureau of Yards and Docks did review the design criteria and wind and wave forces which were to be used in the design of the Texas tower.

Mr. KENDALL. When you say "reviewed," you mean they reviewed the work of the design engineers, is that correct?

Mr. AYERS. Yes, sir.

Mr. KENDALL. The design engineers are the ones who made the study and the original evaluation?

Mr. AYERS. That is correct.

Mr. KENDALL. And the Navy merely reviewed it and finally concurred in it?

Mr. AYERS. Yes, sir, and we saw to it that it was in consonance with our own ideas.

Mr. KENDALL. Briefly, what design criteria was finally adopted?

Captain ALBERS. Four basic criteria: Combinations of wind and wave: With a 70-mile per hour wind, a 60-foot nonbreaking wave; with a 125-mile per hour wind, a 40-foot nonbreaking wave; with a 125-mile per hour wind, a 35-foot breaking wave, which, for the greater part of design, is the controlling factor.

Mr. KENDALL. That is the critical criterion?

Captain ALBERS. Yes; 50 miles an hour with a 15-foot wave, which was used during the erection procedures.

Mr. KENDALL. In order that we may all understand what you are talking about, Captain, when you refer to a 35-foot wave, how is it measured?

Captain ALBERS. From trough to crest.

Mr. KENDALL. Then approximately what portion of the wave would be above mean sea level?

Captain ALBERS. About 60 percent, sir.

Mr. KENDALL. So actually, when you are talking about a 35-foot breaking wave, you are talking about a wave approximately 20 feet above sea level, is that true?

Captain ALBERS. Above the sea level at the time. There are other things that affect the sea level other than waves.

Mr. KENDALL. You mean tides and other increase in the water depth, and so forth?

Captain ALBERS. The water can blow in on these reefs and pile up on them, and increase the average level of the ocean.

Mr. KENDALL. But we are talking about a wave 20 feet above the actual then existing level of the ocean?

Captain ALBERS. That is correct, sir.

Mr. KENDALL. And it is not a wave 35 feet above the level of the water?

Captain ALBERS. That is right.

Mr. KENDALL. Was there any controversy, Captain, in the use of weld connections in Texas tower No. 4?

Captain ALBERS. Not that I remember; I do not remember any controversy on that subject.

Mr. KENDALL. You do have some remembrance of that design?

Captain ALBERS. Yes.

Mr. KENDALL. Do you know, in the original design, how much tolerance was allowed?

Captain ALBERS. The drawings called for one sixty-fourth of an inch.

Mr. KENDALL. Was that increased during construction?

Captain ALBERS. I am unable to answer that, sir. It was not increased during my tour on the job.

Mr. KENDALL. Do you know of any substantial changes that were made in construction or erection procedures at the time you were on the job?

Captain ALBERS. Yes.

Mr. KENDALL. What were those?

DEVIATIONS FROM ORIGINAL DESIGN

Captain ALBERS. The original design called for a pile foundation rather than the sinking of the caisson, as you saw in the picture. Originally, there was to be a temporary work platform installed in the position of the permanent deck, and this was to be installed before the tower was rotated over. Its principal purpose was to carry the equipment to drive the piles.

Senator STENNIS. Carry it where?

Captain ALBERS. Lift the equipment up on it so that the equipment would have some place to sit in order to drive these piles 200 feet under water.

Mr. KENDALL. Why did you eliminate the work platform? Could not it still have been utilized in the erection process?

Captain ALBERS. It served no real useful purpose in the procedure as we adopted it.

Mr. KENDALL. Well, it did mean, did it not, that this heavy permanent platform had to be jacked up on these legs and erected prior to any imbedding of them, and prior to any stiffening of the lining of the legs with concrete?

Captain ALBERS. That is true.

Mr. KENDALL. Would not that exert additional force and stress not calculated originally?

Captain ALBERS. Those forces were considerably less than the maximum wave forces on the completed tower.

Mr. KENDALL. What was the reason for the elimination of the pilings?

Captain ALBERS. It was done at the contractor's request. It was considered, and we felt that the caissons sunk to the bottom are completely the equivalent of the piling that was originally planned.

Mr. KENDALL. How deep was the piling originally designed?

Captain ALBERS. I would have to refresh my memory, sir. I have forgotten. It was in excess of 20 feet.

Mr. KENDALL. Didn't you make a statement just a while ago as to the depth of the pilings?

Captain ALBERS. No, sir, the caissons go down 20 feet.

Senator JACKSON. He was talking about the overall depth.

Mr. KENDALL. The caissons in this tower are imbedded only 20 feet?

Captain ALBERS. That is right.

EMBEDMENT OF LEGS OF TOWERS

Mr. KENDALL. What is the embedment of Texas towers Nos. 2 and 3?

Captain ALBERS. Texas tower No. 3 is 60 feet; Texas tower No. 2 is considerably more; less in diameter. I may have those figures here.

Texas tower No. 2 was 63 feet, sir.

Mr. KENDALL. Was that the piling, or just the embedment?

Captain ALBERS. Just the embedment of the caissons.

Senator JACKSON. And what was it for tower No. 4?

Captain ALBERS. Twenty feet.

Senator JACKSON. May I just ask this question?

What kind of soil in each?

Captain ALBERS. All three of them were compact sand; sand with some ground.

Mr. KENDALL. Actually, as built, Senator, the embedment of Texas tower No. 4 was only 18 feet, I believe.

Well, will one of you other gentlemen be looking, if you have the information, to find out specifications for the piling as originally designed?

Mr. EDWARDS. We do not have it here, sir.

Senator JACKSON. Might I ask this question?

Senator STENNIS. Certainly.

Senator JACKSON. Was the ocean soil the same at all three sites?

Captain ALBERS. Substantially the same at all three sites.

Senator JACKSON. I understood there were some differences. I just raise this question, that at site No. 4, it was more silt and less the firm type of sea soil than was involved in No. 2 and No. 3.

Captain ALBERS. It is my understanding, Senator Jackson, that it was very hard sand in all three of these sites. The other two towers which were not completed did have a different appearance. One was solid rock, and one was loose boulders.

Senator JACKSON. What is the reason—go ahead.

Senator STENNIS. The question comes to my mind, Why put this one 20 feet and the others less?

Captain ALBERS. The other towers do not have any intermediate bracing on the column, which makes quite a bit of difference in your design.

Senator JACKSON. The only trouble is the other two are standing and this one is down.

Captain ALBERS. The other two are merely driven into the ground, and you have no support until you get to the top of the tower.

Senator STENNIS. The weight was much greater on No. 4, was it not, the weight of the tower?

Captain ALBERS. It was somewhat greater, yes.

Senator STENNIS. What percent greater?

Captain ALBERS. I would be estimating, about 15 percent.

Senator STENNIS. And the waves were greater, were they not; anticipated waves?

Captain ALBERS. The same, sir.

If we take this one leg here and you tend to put it over like a stake driven into the ground, it will flop right out. But if you take a stool with three legs braced together and push it, it tends to slide, rather than to topple over.

As we use the phrase in engineering, there is very little bending moment on this particular caisson, where you have a structure as that is originally put together. Where you do not have that, you do have a considerable bending moment computed to the bottom of the tower leg.

Senator STENNIS. Well, in great deference to you, it is just shocking to learn that this is only 20 feet deep; that is, shocking to a layman; to me, at least.

Captain ALBERS. It will figure perfectly satisfactory, sir. If I may point out, that is one part of the tower that was not damaged. Those caissons are still there.

Senator STENNIS. It did not give way, where the others did.

Captain ALBERS. That is the great difference, the difference in the bracing system.

Senator STENNIS. Senator Jackson?

Senator JACKSON. As I understand from the interrogation by counsel here, it was brought out that the designs were submitted by other competing firms?

Captain ALBERS. Preliminary designs, yes; schemes, I think you would preferably call them.

Senator JACKSON. Well, did the Navy, or you, or other people really review the different approach that these other people made as compared to the people who got the contract?

Captain ALBERS. Yes, sir, we studied many other schemes in addition to those two.

Senator JACKSON. I understand, but you say these various schemes or proposals of designs were submitted so that you had an opportunity to get their philosophy as to how they felt it should be built?

Captain ALBERS. Yes, we went out and investigated them, and they are all covered in the feasibility report.

Senator JACKSON. Could you explain briefly how the competing scheme compared with the one that was accepted? How did it differ? I understand that it differed.

Captain ALBERS. The DeLong system as originally submitted was the one we actually used on tower No. 2. That system was not suitable

for use on tower No. 4, and required some modifications. As of this time, I have forgotten what his modifications were to be.

Senator JACKSON. What did they submit on No. 4?

Captain ALBERS. They did not submit one on No. 4, sir.

Senator JACKSON. They did not submit a proposal on tower No. 4?

Captain ALBERS. They submitted a bid proposal based on our design, which is this design.

Senator JACKSON. And their proposal was based on the design that you had?

Captain ALBERS. That is correct, sir. That is our customary procedure. We furnish designs to the construction contractors.

Mr. KENDALL. I think we might be talking about two different things here. I think the Senator is talking about what they submitted as a suggested design prior to the selection of the design engineer?

Senator JACKSON. That is my question.

Captain ALBERS. They submitted the same design we used on tower No. 2, but it was not suitable for use on tower No. 4, because the legs did not have any bracing in them.

Senator JACKSON. Well, did it not differ in any other from this one? Was it the same thing?

Captain ALBERS. This was the DeLong system that was discussed before the A. & E. made his design.

Senator STENNIS. Was it three legs that they proposed?

Captain ALBERS. Their system, I do not believe, went so far as to the number of legs. Their system can be used on three or four or more legs.

Senator JACKSON. Do you know what they proposed, whether it was three or four legs?

Captain ALBERS. I think they proposed a multiplicity of legs, 8 or 10, if I remember correctly.

Senator JACKSON. That is different, then, from what we are talking about here, and what later turned out to be the design for No. 4.

Captain ALBERS. Yes.

Senator JACKSON. How many feet did they propose driving the legs in?

Captain ALBERS. I do not know whether that is covered.

It was not covered in that much detail, Senator.

Senator JACKSON. That was not proposed?

Captain ALBERS. No, sir.

Senator JACKSON. Why did they select a firm that had not had experience in this particular area, as compared to someone who had done the pioneering work?

Captain ALBERS. We wanted to evaluate all of the systems that were then in existence and in the process of being developed, and then put them out for competitive bids, which every contractor could bid on.

Senator JACKSON. Well, I am talking about design now. This is the crucial question here, because it is apparent that the design failed. Why did you select, and on what basis did you select, someone who had not had experience in this area?

It turns out that the one that collapsed was designed by someone who had not had the experience. Did the DeLong firm build one of these others that is still standing?

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Captain ALBERS. DeLong Corp. built one tower, and it is still standing.

Senator JACKSON. Have you had any trouble with it?

Captain ALBERS. Not to my knowledge.

Senator JACKSON. On what basis, then, did you select someone who had had no experience in this field?

Captain ALBERS. Moran, Proctor designed the one that is still standing; that was built by the DeLong Corp. Part of the DeLong scheme that we incorporated was the use of their jacks.

Senator JACKSON. But DeLong did not agree with this design on tower No. 4?

Captain ALBERS. DeLong did not agree on this rotation, as we called it, template in the movie, and the difficulties he encountered in marrying the floating platform to these three legs at sea.

Senator JACKSON. Well, is not this rather crucial?

Captain ALBERS. That part of the operation we got through successfully, sir. DeLong's principal design was use of his jacks that he has developed, and they were very satisfactory and they were used on Texas tower No. 2. They could have been used on Texas tower No. 3, but the new contractor elected to use jacks of another firm. As a matter of fact, he was forced to.

Mr. KENDALL. Captain, Texas tower No. 2 was not built as it was originally designed; was it?

Captain ALBERS. Yes, I think so.

Mr. KENDALL. Well, Captain, is it not true that it was almost a process of design and construction at the same time?

Captain ALBERS. That is correct. We were starting to build them before we completed our design.

Mr. KENDALL. You would not say, therefore, that DeLong entirely agreed with the design on Texas tower No. 2, would you? What happened to the braces that were originally on No. 2? They are not there now?

Captain ALBERS. No; they are not.

Mr. KENDALL. Well, DeLong did not agree with the design on Texas tower No. 2, and you actually designed it as you built it?

Captain ALBERS. I do not remember Mr. DeLong or his associates objecting to the design on Texas tower No. 2.

Mr. KENDALL. You mentioned some objection that DeLong had. Did he not also object to the use of the pin connections that had been designed for use in Texas tower No. 2?

Captain ALBER. Not that I remember.

Mr. KENDALL. You do not remember?

Captain ALBERS. No, sir.

Mr. KENDALL. You gave us the depth of embedment of the three towers. Would you give us the water depths?

Captain ALBERS. Texas tower No. 2 was 53 feet; Texas tower No. 3 was 85 feet, and Texas tower No. 4 was 185 feet.

Mr. KENDALL. Texas tower No. 4 was by far the deeper?

Captain ALBERS. That is correct.

Mr. KENDALL. Incidentally, did you get those figures on the depth of the piling as designed?

Mr. EDWARDS. We do not have that here, sir.

DETERMINATION OF DESIGN CONFIGURATION

Mr. Kendall. Captain, what were the considerations that led to the fixing of the platform of Texas tower No. 4, 67 feet above sea level?

Captain Albers. It was a combination of wave height, tide height, increase in the water depth, plus the clearance.

Mr. Kendall. For what height wave would that give clearance according to the design criteria?

Captain Albers. A 96-foot wave.

Mr. Kendall. Was the tendency of the waves to climb when they strike a solid object like these caissons taken into consideration?

Captain Albers. Yes, sir.

Mr. Kendall. Well, Captain, I believe you know now, do you not, that it is an accepted fact that at least once, in September of 1960, the wind and wave forces exceeded this design criteria?

Captain Albers. So I have been advised.

Mr. Kendall. Is it not true, Captain, that the tower was designed with the thought of presenting the least resistance to the forces of the waves and wind?

Captain Albers. That is correct.

Mr. Kendall. Will you show us where the X-bracing was installed in 1960?

Captain Albers. This red bracing on the model.

Mr. Kendall. Would you not, as an engineer, say that was contrary to and militated against the original design?

X-BRACING ABOVE WATER ABSORBS ADDITIONAL FORCE FROM WAVES

Captain Albers. It absorbed additional force from these waves, and I have not made any computations on it nor seen any. I am told, however, that it added also to the strength of the tower.

Mr. Kendall. But, actually, it was placed in the area where the force of the waves was the greatest as far as the tower is concerned?

Captain Albers. Greater than where our braces were installed; yes, sir.

Mr. Kendall. You will agree that it did introduce a new stress factor into the tower that would have to be figured?

Captain Albers. Would require a complete reanalysis.

Mr. Kendall. Now, Captain, as you know, one of the primary purposes of this hearing is to determine why Texas tower No. 4 collapsed. You are an engineer and you are familiar with the design, and at least a part of the construction of tower No. 4. Do you have any thoughts on this point?

ADEQUACY OF DESIGN CRITERIA

Captain Albers. I would say it failed because of the wave action being more than the designed criteria.

Mr. Kendall. Would this mean that the original design was faulty or inadequate?

Captain Albers. I think our original design criteria, if I had to do it over again, would be increased. But the tower did not fail under

Hurricane Donna when we had these big waves. It was severely damaged, but the tower did not fall down in Hurricane Donna, when it got its most severe test.

Mr. KENDALL. It was subjected to successive damage, and apparently increasing deterioration, was it not?

Captain ALBERS. Would you repeat that, sir?

Mr. KENDALL. I said it was subjected from its inception to successive damage and increasing deterioration, was it not?

Captain ALBERS. I do not know that of my own knowledge.

Mr. KENDALL. You know the history of what has been done out there. What would that suggest to you as an engineer?

Captain ALBERS. It would suggest that they have had considerable difficulty with the braces on the A–B side.

Mr. KENDALL. So you would say it is at least within the realm of possibility that the original design was faulty or inadequate, would you not?

Captain ALBERS. No, I shall not agree with that.

Mr. KENDALL. You would not say that is even a possibility?

Captain ALBERS. It could be a possibility, yes.

Mr. KENDALL. Well, would it be a possibility that the tower was not built up to design specifications?

Captain ALBERS. I do not think so.

Mr. KENDALL. You do not think that is a possibility?

Captain ALBERS. Well, I——

Mr. KENDALL. Well, is it possible that the tower, after being built, was subjected to stresses and forces that were not taken into consideration in the original design?

Captain ALBERS. Hurricane Donna was in excess of the original design criteria.

Mr. KENDALL. And in that case, it would indicate some faults with the design, would it not?

Captain ALBERS. With the design criteria; yes, sir. I have mentioned that.

Mr. KENDALL. The design is based on the criteria?

Captain ALBERS. That is correct.

Senator JACKSON. Was not this tower in trouble before Hurricane Donna? Donna is getting a lot of blame here, but I thought this tower had some problems before Hurricane Donna.

Captain ALBERS. I understand there were some problems, Senator.

Senator JACKSON. So if it is predicated on Donna, Donna being beyond the specifications, it would occur to me that there was some question as to the feasibility of this design, forgetting about Hurricane Donna.

Captain ALBERS. Senator, all of the troubles that they had were on one side of the tower. On the other two sides of the tower, there were no troubles.

Senator JACKSON. Was not there some serious trouble prior to Donna last fall?

Captain ALBERS. There was excess motion; yes, sir.

Senator JACKSON. Was it not called Old Shaky or something?

Captain ALBERS. Yes, sir.

Senator JACKSON. Well, I understand that in July 1958, that there were complaints by operating personnel of considerable platform

motion on Texas tower No. 4. The proximate cause of the disaster is a nice thing for lawyers to argue about. They argue these cases in court all the time. But it seems to me that if you say the proximate cause of the collapse was Hurricane Donna, I think this would be an error. It seems to me the thing was cumulative, just based on the facts presented here, to which there seems to be no dispute, Mr. Chairman.

That is all.

Senator STENNIS. Thank you, Senator Jackson.

Counsel, were you through?

Mr. KENDALL. I have about one more question, Mr. Chairman.

Captain, are you familiar with the fact that it is shown in the study to develop the design criteria, the weather reports over the past 20 years—this is prior to the design of the tower—showed that there was a maximum wind of 128 miles an hour, and that the computed average of the 10 percent highest waves during easterly storms was 66 feet?

Captain ALBERS. Yes, sir.

Mr. KENDALL. Well, if you only designed for a wind of 125 miles an hour and 35-foot waves——

Captain ALBERS. A 35-foot breaking wave, sir. We designed for a 60-foot nonbreaking wave.

Mr. KENDALL. Well, were you not designing for a 60-foot, nonbreaking wave, and here is the record to show there had been 66-foot nonbreaking waves.

Captain ALBERS. That is correct, sir.

Senator STENNIS. That is correct?

Captain ALBERS. Yes, sir.

Mr. KENDALL. So the actual experience showed that the weather, the wind and the waves, had exceeded the design criteria over a period of 20 years?

Captain ALBERS. Not simultaneous, sir.

Mr. KENDALL. Well, they have been exceeded at some time or other, whether in combination or not. You have had experience of winds of more than 125 miles an hour?

Captain ALBERS. That is correct, sir.

Mr. KENDALL. And nonbreaking waves of more than 60 feet?

Captain ALBERS. That is correct. We applied our criteria simultaneously, though. The wind and the wave simultaneously. In addition, we had considerably more strength in the steel than we used up in our design. We used normal working stresses.

Mr. KENDALL. Do you know what Hurricane Donna did?

Captain ALBERS. I have been told; yes, sir.

Mr. KENDALL. What is your information about the wind velocity? Wasn't it 132 miles an hour?

Captain ALBERS. Yes, sir; but I have no idea how it was measured.

Mr. KENDALL. And about 50-foot breaking waves?

Captain ALBERS. I have been told that; yes, sir.

Mr. KENDALL. That is all I have, Mr. Chairman.

Senator STENNIS. I have just a very few questions, Senator Jackson, before I come to you again.

TOWER NO. 4 IN TROUBLE AT THE OUTSET

Now, Captain, as I understand, you referred to Hurricane Donna, and in agreement with Senator Jackson, it seems to me as a practical matter that your troubles started with the tower before you got it up. Two of these braces came loose during the tow. I believe you were not there then; you were not the officer in charge. You had already gone to another assignment?

Captain ALBERS. That is correct, sir.

Senator STENNIS. But you have familiarized yourself with what happened?

Captain ALBERS. To some extent; yes, sir.

Senator STENNIS. Now, what does the fact that these braces broke in putting this structure up, suggest to you? That they were wrongly put on, that something struck them; or was it a wave, or just the strain of being tilted? It seems to me that should have been a signal that all was not well. What is your judgment of it?

Captain ALBERS. Those braces were to be temporarily lashed in place. I have no idea what these temporary lashings consisted of. I would think that they were broken off, the temporary lashings were broken off during the storm, which I understand they encountered on the way out. They did not break in the direction in which they were designed to work. It was a long, loose member connected with the pins, and it is just like bending your elbow in the wrong direction; it will break before it will move.

Senator STENNIS. Well, did that indicate any faulty structure, any faulty design, or any faulty material?

Captain ALBERS. No, sir.

Senator STENNIS. Was not that a warning of more trouble to come later?

Captain ALBERS. I would not have taken it as such; no, sir.

Senator STENNIS. So you think that point can be ignored?

Captain ALBERS. It is according to what you mean by ignored.

Senator STENNIS. It was not a warning to you, a sign of any defect of any kind?

Captain ALBERS. No, sir.

Senator STENNIS. What was it that caused you to put those additional bolts on? Something had happened there. You came back and tried to reinforce it with the collars that go around those big piers. What was the reason for that?

Captain ALBERS. The two diagonal braces were missing. They were lost.

Senator STENNIS. Are these the ones that were pulled away?

Captain ALBERS. Those were the two that were lost.

Senator STENNIS. Why was it necessary to put the collars on?

Captain ALBERS. Because when the pieces were lost, they bent the connection plates to which the members were pinned.

With this structure horizontal, and this brace [indicating] pinned merely at one end, then it fell down and got the full weight of the rod on it; it broke and bent the plates to which it was to be pinned.

Senator STENNIS. I see.

Did you replace the braces which had been detached?

Captain ALBERS. The braces that were broken off were replaced.

We saw them putting them down in the movie. But they had to be connected to something other than that they were designed for connection to.

Senator STENNIS. All right. When you replaced them is that when you affixed the collar and secured them with it?

Captain ALBERS. That is correct, sir.

Senator STENNIS. In your opinion, did that restore the tower to the strength of the original design, and put it in as good condition as it would have been had the brace not been lost?

Captain ALBERS. I have not looked at that design, sir. I do not feel qualified to answer that.

Senator STENNIS. What is your judgment as an engineer?

Captain ALBERS. A joint can be designed of that nature that will be sufficiently strong; yes, sir.

Senator STENNIS. You decline, though, to make any comment on what was done in this particular case.

Captain ALBERS. I do not know how the joint was designed and installed, sir.

Senator STENNIS. Was it sound engineering to try to make the repair in that way?

Captain ALBERS. Yes, sir.

DEFECT IN COLLAR REPAIR

Senator STENNIS. Now, what was the next thing that happened before Hurricane Donna? Other trouble developed. I am not accurate enough in my information to designate——

Captain ALBERS. I am told that this collar became loose.

Senator STENNIS. The collar that was put on, yes.

Captain ALBERS. Which allowed it to move up and down.

Senator STENNIS. If that happened, would you not know it was defective? You just said, as I understand it, you would not venture an opinion, but if that collar came loose, would that not show that it was defective, or that it was not going to hold?

Captain ALBERS. It indicates that there was something wrong, yes, sir.

But I cannot say that the design of that collar was incorrect.

Senator STENNIS. All right, I am not asking you to say anything, now.

But if you had been there and were informed of the fact that this collar had broken loose, as an engineer, that would have brought knowledge to you that there was something wrong; is that right?

Captain ALBERS. I think so, yes.

Senator STENNIS. Well, do you not know so?

Captain ALBERS. Yes, sir.

Senator STENNIS. Well, let us just say it, if you know it.

Captain ALBERS. Yes, sir.

Senator STENNIS. What would you have done?

Captain ALBERS. That would require considerable study, Senator.

Senator STENNIS. I am sure it would, but give us your professional opinion, if you are willing, as to what you would have done.

Captain ALBERS. I would prefer not to give my professional opinion without complete study of the situation.

Senator STENNIS. Well, I do not want to get beyond bounds now, but it appears to me that you are eminently qualified to have an opinion on that. If you would rather not, all right.

But you do say flatly that something should have been done?

Captain ALBERS. When it was found that it was sliding and slipping, yes, sir.

Senator STENNIS. And something of a substantial nature should have been done, not just a little adjustment of some kind to remedy that defect?

Captain ALBERS. To keep it from moving, yes, sir.

Senator STENNIS. Now, was that done?

Captain ALBERS. I am told that they changed the type of bolts, and put one in there and secured it.

Senator STENNIS. What was done, if you are able to tell me that?

Captain ALBERG. They put in a T-bolt, inside of the Dardelet bolts, we used in the design.

Senator STENNIS. Now, did the T-bolt hold?

Captain ALBERS. To the best of my knowledge, yes, sir.

Senator STENNIS. Did they really get the T-bolts in there and finish the job, or was that just an effort which was never completed?

Captain ALBERS. As far as I know, that sleeve was complete.

Senator STENNIS. You have not made any specific inquiry about that; is that correct? I know you were not there and you have no actual knowledge.

Captain ALBERS. No, sir. I have not inquired as to what further was done.

Senator STENNIS. According to your information—we just want your opinion on these matters—what was the next thing that happened?

Give us information about the motion of the tower and other major defects according to your information.

MOTION OF TOWER DECREASES

Captain ALBERS. I believe that upon the completion of this sleeve, the motion of the tower decreased perceptibly.

Senator STENNIS. Upon the completion of the second sleeve job?

Captain ALBERS. Yes, sir.

Senator STENNIS. What was the next thing that happened between that time and Hurricane Donna? What malfunction occurred?

Captain ALBERS. As I understand it, due to the slippage and the movement of this sleeve, some of the pins and some of the braces were worn on the A–B side of the tower. They still had motion and I am told that that is when they installed these braces up here.

Senator STENNIS. That is the above-water X-bracing which is above the brace where there had been difficulty with the bolts?

Captain ALBERS. That is correct, sir. The bolts at this level.

Senator STENNIS. So that when the original trouble started with the breaking off of these braces, in erecting the tower, that led to a repair and that repair was not effective and that led to another one. In that process, long before Hurricane Donna, there was gradual deterioration; is that not correct?

Captain ALBERS. There were continued difficulties on the A–B side, yes, sir.

Senator STENNIS. Well, there was a gradual deterioration of this tower's stability, was there not?

Captain ALBERS. Yes, sir.

Senator STENNIS. And after these things had happened the X-bracing was installed which is shown in red on the tower model. You have it very well marked there.

Captain ALBERS. This is it that they put in; yes, sir.

Senator STENNIS. Was that a sound step to take, in your opinion?

Captain ALBERS. I have not seen all the computations on them, but I believe perhaps it was.

X-BRACING ABOVE WATER INCREASED FORCES ON TOWER

Senator STENNIS. Under the conditions then existing, you think that was a sound step to take?

Captain ALBERS. I think it was a sound step in the right direction.

Senator STENNIS. Well, it looks that way to me, but didn't that increase the hazard to the tower because it obstructed the waves as they passed through?

Captain ALBERS. It increased the forces on the tower; yes, sir.

Senator STENNIS. And therefore increased the hazard?

Captain ALBERS. It also increased the strength of the tower to resist the forces.

Senator STENNIS. We shall get to that in a minute. Let us take it one at a time.

Part of your design was to keep the structure unobstructed, so that water could pass through freely?

Captain ALBERS. Yes, sir.

Senator STENNIS. But with this defective situation, the X-bracing was installed and the immediate effect of that was to present more resistance to the waves, and that increased the stress?

Captain ALBERS. That is correct.

X-BRACING ALSO INCREASED TOWER STABILITY

Senator STENNIS. All right. Now, offsetting that to a degree, and in part, the X-bracing did make the whole structure stronger; is that correct?

Captain ALBERS. That is correct, sir.

Senator STENNIS. Now, did one offset the other, did one equal the other, or was one twice the other, in your judgment as an engineer?

Captain ALBERS. Senator Stennis, I do not believe I am qualified to answer that without extensive study.

Senator STENNIS. All right. I know you are trying to answer. Now, let us put it this way: As an engineer, are you convinced that it did strengthen it? Was the net gain greater than the added burden?

Captain ALBERS. I have read reports by qualified engineers that it did increase the strength of the tower.

Senator STENNIS. What is your opinion about it?

Captain ALBERS. I think it is very likely that that is true.

Senator STENNIS. All right, you think it did more good than harm?

Captain ALBERS. That is right, sir.

Senator STENNIS. All right.

What was the next step that happened between then and Hurricane Donna, if you recall?

Captain Albers. I do not believe I have any more information on that, Mr. Chairman.

Senator Stennis. All right. Now, what is your opinion on this? After you got the X-bracing installed and before Hurricane Donna, what, in your opinion as an engineer, was the relative strength of the tower compared to its strength when it was first erected, everything considered?

Captain Albers. I would say that it approached the original design strength.

Senator Stennis. Approached the original design strength. How nearly did it approach it? Was it approximately the same, 70 percent, or 85 percent, as best you can tell?

Captain Albers. This is a pure guess. I would say 80 or 85 percent.

Senator Stennis. You are guessing that it was 80 or 85 percent?

Captain Albers. I have made no computations on this.

Senator Stennis. With all due respect to you, I do not believe we can travel on guesses, and you should be able to give us more in view of your professional standing and prestige. Let us leave out that word "guess," if you can. Do you have a professional opinion?

Captain Albers. No, sir.

Senator Stennis. You were the man who handled this from its inception. You followed it through to a certain point; you had official duties; you are well versed in the facts. Can you not do more than guess?

Captain Albers. No, sir; I am not well versed in the facts. I do not have the details.

Senator Stennis. You have been acquainted with what developed later. As in court, you have been given the hypothetical case, so to speak. Now, you have been told what happened here later, and you have discussed it very intelligently.

Captain Albers. It would take considerable study to put more than an estimate on the percentage of these several modifications to them, sir. I do not feel qualified to make a statement on that without complete study.

Senator Stennis. I am not going to press you for that. However, with all of your knowledge and ability, and your knowledge of the facts of this case, it seems to me that you would have something more than a guess about the relative strength. You are an engineering officer with a great deal of responsibility. Few engineering officers could not give us an estimate on the relative strength after being acquainted with the facts.

Captain Albers. I was not connected with any particular part of this work. There are counterbalancing factors involved. In one way, it increases the forces; in another way, it increases the ability to withstand forces. I believe it would be beyond prudence as an engineer to try to give you more than a guess.

Senator Stennis. All right, I respect your opinion.

Now, added to all that we have been discussing, Hurricane Donna came along. You are familiar with the approximate waves and wind forces of Hurricane Donna and the stress this tower underwent as a result, are you not?

Captain ALBERS. Actually, I have seen the data on the wave lengths; I have seen some information on the wave height. It has been estimated that they had 50-foot breaking waves there. I am advised that light structural steel was dented on the side of the platform.

Senator STENNIS. Well, yes; I just wanted you to have all of that information before you. Could you give us quickly the information about the height of the waves and the force of the wind?

Mr. KENDALL. It was a 132-mile-an-hour wind.

Senator STENNIS. The wind during Hurricane Donna was 132 miles per hour, and the breaking waves were 50 feet. With that information before you, and in view of the condition of the tower as it then existed, what was the situation, then, even though the tower did not collapse? What is your opinion as to whether or not a greater effort should have been made to effect repairs? Can you give us an opinion?

We have been talking about the time prior to Hurricane Donna. Now I want to know what happened during and after Hurricane Donna.

Captain ALBERS. Can I ask how those measurements were determined—that they were actual breaking waves and that the waves were of that magnitude, and that the wind was, in actuality, that much?

Senator STENNIS. What is the record on that, gentlemen of the staff?

Mr. KENDALL. This is information that was furnished to us by the Air Force, Captain.

Captain ALBERS. As I understand it, the anemometer to measure the wind blew away at 100 knots. I have heard that.

The determination of whether a wave is breaking or not is extremely difficult in cases of high wind.

Senator STENNIS. Well, I just want to get your professional opinion about these things.

Captain ALBERS. It would appear that the wave and winds were in excess of the criteria.

Senator STENNIS. Yes. Well, here is a memorandum I have here, "November 1960, flying bridge repaired and diving operations begun."

The flying bridge was above the water?

Captain ALBERS. The flying bridge was a movable platform placed up under the platform for maintenance of the bottom of the tower.

NEW CABLE BRACING PROPOSED

Senator STENNIS. This says the divers reported extensive damage above and below the water, and that it will need bracing, consisting of three strands of cable bracing in a crossed pattern on the A–B side.

That is what I wanted to come to. You see the red lines there representing the cable bracing?

Captain ALBERS. Yes, sir.

Senator STENNIS. Now, as an engineer, if the condition of the tower was such, in September 1960, that it would require the addition of cable bracing, would not that be an indication to you that the tower then was in worse condition than before Hurricane Donna?

Captain ALBERS. Would you repeat that, sir?

Senator STENNIS. I stated that they were talking about installing cable bracings. Would you judge from that, as an engineer, that

there was need for further bracing, further repair, and further strengthening of this tower?

Captain ALBERS. These cables were to replace the diagonals that had been broken by Hurricane Donna.

Senator STENNIS. They were going to replace the diagonals that had been broken by Donna?

Captain ALBERS. That is correct, sir. At one stage of our deliberations on how we would design this tower, we considered using cables as a means of diagonal bracing at that time.

Senator STENNIS. Here is my point: If the tower was in such shape that these cable bracings had to be installed, what do you think, then, about the relative safety of that tower as compared to when it was first erected? Wouldn't you say it was considerably worse than it was before Hurricane Donna?

Captain ALBERS. I think that is probably true, Mr. Chairman. I do not know just exactly which braces were broken. I do know that several braces were broken and that these were suggested; at least, I have been told that these were suggested to replace those broken braces.

Senator STENNIS. You understand I am not trying to embarrass you or push you in a corner. I just want your professional opinion. I know it is worthy, and I do not know enough about all those additional facts. Apparently, you have not had a chance to be informed on that either, so I shall not press you for an opinion. But just on the face of it, the fact that these engineers planned to install this cable bracing, would not that show that additional injury and weakening had resulted from Hurricane Donna?

Captain ALBERS. I am told that two more braces were broken, and there was no ready way to replace those braces. It is practically impossible to do welding under water.

Senator STENNIS. With those braces broken, would you not consider it unsafe to try to operate the tower until they were repaired or replaced?

Captain ALBERS. I would not have any more people out there than was necessary to repair it.

Senator STENNIS. You consider that it was highly unsafe, do you not?

Captain ALBERS. I would consider it would be unsafe if hit by another large storm, yes, sir.

Senator STENNIS. It proved to be highly unsafe even though it was not hit by an especially large storm, right?

Captain ALBERS. That is correct.

Senator STENNIS. Senator Jackson?

Senator JACKSON. Did the same design criteria apply on towers Nos. 2 and 3 as applied on tower No. 4?

Captain ALBERS. Yes, sir.

Senator JACKSON. Do you know whether—perhaps Mr. French of the staff could answer this. Have towers No. 2 and No. 3 been subjected to the same velocity of storm conditions as No. 4, or comparable, or somewhat similar?

Captain ALBERS. They have been subjected to one big storm, tower No. 2, that I know of. Water approached the platform but I do not believe we had it up against the side of the platform, as was reported on tower No. 4.

Senator JACKSON. Well, let me put it this way. In connection with towers No. 2 and No. 3, have they had storms at least comparable to what tower No. 4 had, prior to Hurricane Donna?

Captain ALBERS. They had one big storm that I know of that I cannot say was in excess of the criteria; we do not know. But it approached the design criteria.

Senator JACKSON. But the point is, tower No. 4 was in trouble prior to Hurricane Donna, so that there was a question of whether this tower really was meeting the design specifications.

Captain ALBERS. All of the trouble before Hurricane Donna, I think, can be traced to this one brace here that it was necessary to replace due to the fact that it was lost during the erection operations.

Senator JACKSON. And you say they can all be traced to that?

Captain ALBERS. I believe they can, sir.

Senator JACKSON. Well, now, are there any differences in design of towers No. 2 and No. 3 as compared with No. 4?

Captain ALBERS. We used exactly the same criteria and the same design stresses. There is considerable difference in that tower No. 2 and tower No. 3 do not have any of this bracing system.

Senator JACKSON. Towers No. 2 and No. 3 do not?

Captain ALBERS. They have none of that bracing system.

Senator JACKSON. Why did you have the bracing system in No. 4?

Captain ALBERS. The water here is so deep that it required intermediate bracing of the columns. This column approaches the height of a 22- or 23-story building, sir.

Senator JACKSON. Knowing all that has happened, having the benefit of Monday morning quarterbacking, what would you do on this to change it if you had it to do over?

Captain ALBERS. I believe I would raise the tower somewhat and use a somewhat larger wave as a criterion.

Senator JACKSON. You would not change the overall design of it?

Captain ALBERS. I feel that the overall design is correct. We have discussed design and the Kuss patent, and so forth. The Kuss patent was merely a scheme of rotation of the platform. It does not go into such details as pins and so forth. I do not think the use of pins is a part of the patent. It is merely a scheme of erection of a tower.

Senator JACKSON. In your judgment, the depth of the legs in the sea soil would not have any real bearing on what happened after it was erected?

Captain ALBERS. I feel sure that they did not have anything to do with it, because in fact, they are still there; at least, I am told they are still there. As I understand it, there was no damage done to the foundations of the platform. The legs were broken some distance above the caissons.

Senator JACKSON. In other words, in your judgment, the fact that there was a depth of only 18 feet for the sinking of the legs was not the proximate cause of the ultimate difficulty that led to the collapse?

Captain ALBERS. In my opinion, it had no relationship with the failure of the tower. I am told that when the tower failed, all the braces on this AB side were broken and ineffective.

Senator JACKSON. Why do you feel that towers No. 2 and No. 3, that have been through some rough storms, have not encountered any difficulty as compared with No. 4?

Captain ALBERS. I do not believe they have recived a storm as big as No. 4.

Senator JACKSON. I understood that prior to Hurricane Donna, towers No. 2 and No. 3 had suffered some similar storms, and tower No. 4 was in trouble prior to Hurricane Donna. Let us forget what happened after Hurricane Donna.

Captain ALBERS. I think it can be traced to the loss of those braces. It is kind of the story that if the nail was not lost.

Senator STENNIS. It is kind of what?

Captain ALBERS. The loss of these braces at the time of erection.

Senator STENNIS. Oh, erection; yes.

Senator JACKSON. And you feel if those braces had been properly replaced, this tower should at least have been in good condition up to Hurricane Donna?

Captain ALBERS. That is correct, sir.

Senator JACKSON. You would say it would be gross negligence, would you not, if they failed to replace the braces?

Captain ALBERS. No, sir.

Senator JACKSON. You would not?

Captain ALBERS. No, sir.

Senator JACKSON. What kind of negligence? Any?

Captain ALBERS. I cannot see any negligence in what I have reviewed on the situation.

Senator JACKSON. You do not see any negligence, knowing what you have had a chance to review, in the maintenance of this tower right on up until the end?

Captain ALBERS. When you get to the very end—I would prefer not to answer that question, if I may withdraw from it.

Senator JACKSON. Well, now, wait a minute though.

I submit, Mr. Chairman——

Captain ALBERS. Up through Donna, I see no indication of negligence.

Senator JACKSON. Up through Hurricane Donna?

Captain ALBERS. Yes, sir.

Senator JACKSON. Even if it was called Old Shaky and there were warnings from the people out there? In other words, you see no negligence even though a prudent and reasonable man might foresee that a storm might suddenly come along and you have all these people on board? It did not happen right at that time.

Captain ALBERS. After Donna, I believe they reduced the crew to the amount necessary to repair it.

Senator JACKSON. Yes; but was there not a chance that prior to Hurricane Donna you could have a comparable type of storm hit the tower when it was then in a shaky condition?

Captain ALBERS. Motion does not necessarily mean lack of strength, sir. Although the strength was not up to its full design, they were doing their best to correct these deficiencies.

Senator JACKSON. Well, something could be resilient all right and take it, and it may be good, but do you think that would apply in this case?

Captain ALBERS. It would be preferable that the tower were rigid.

Senator JACKSON. Do you think that the fact that it was shaky was a warning or not as to the structural sturdiness?

Captain ALBERS. I think it was a warning that something was required to be done.

Senator JACKSON. Well, then, was it prudent to keep these men out there when the warnings started to come in, in 1958, I believe? There were complaints sent by operating personnel in July 1958, of considerable platform motion on Texas tower No. 4.

You know, we are just trying to be fair and judicial and to get the facts. There are two problems to this, Captain, that are evident to me. It does not take very long to see what is involved here.

One: Was due care exercised in providing the proper design, followed with proper construction? That is the first.

Secondly, when things started to happen, was due care and prudence exercised by those responsible for keeping personnel on this tower, even though certain known facts existed regarding the credibility of the structure? This is the whole case.

Captain ALBERS. From what I know of the case, up through Donna, I would say that due prudence was exercised; yes, sir.

Senator JACKSON. After Hurricane Donna hit, was due care and prudence exercised by keeping operating personnel—not maintenance but operating personnel on the tower?

As Senator Stennis, the chairman, pointed out, this is a hypothetical question. It is also based on fact.

Captain ALBERS. I went aboard Texas tower No. 2 when we were building it, with Colonel DeLong, who is sitting out there. We went aboard from a cutter because a hurricane was coming and we did not have the tower embedded in the ground at all. We went aboard voluntarily and stayed there and tried to get that tower down. I think we are faced with such a situation here. They kept only the people aboard who were necessary for the repairs.

Senator JACKSON. You say that you went on tower No. 4?

Captain ALBERS. Tower No. 2.

Senator JACKSON. I am talking about tower No. 4.

Captain ALBERS. It was tower No. 2 that I went aboard in the face of the hurricane, and I knew that if that hurricane hit, the tower would not stand up.

Senator JACKSON. I understand that. But in your judgment, was due care and prudence exercised by keeping the operating personnel on tower No. 4 after Hurricane Donna?

Captain ALBERS. They needed sufficient personnel to make water, to make steam, to make electricity and things of that nature and I believe they cut the crew down to just that crew.

Senator JACKSON. Well, I thought they had the full crew out there.

Captain ALBERS. No; as I understand it, they reduced it to 14 men, which is probably the minimum that can operate the boilers, the evaporators, the galley, and things of that nature.

Senator JACKSON. Well, I stand corrected.

Senator STENNIS. They reduced it in the latter part of November, Senator Jackson.

Do you have something further?

Senator JACKSON. No. That is all.

Senator STENNIS. Just one further matter here.

Captain, there is a marker on the tower model. It is around on this side, on that lowest brace, the lowest brace that is marked. What does that say?

Captain ALBERS. "Member detected broken January 6, 1961."

Senator STENNIS. That was the last broken structure, as I understand it, that these divers found. That was found after it had already been decided to put in the additional cable bracing.

Now, directing your attention to that and to the other facts that you know about this matter from Hurricane Donna on, there is no question that during that period, that is, from Donna onward in view of the condition of the tower a highly dangerous situation existed, especially at that time of year. Is that not correct?

Captain ALBERS. I agree, sir.

Senator STENNIS. And that you would not consider it structurally sound at all from an engineering standpoint, if I use the right term; you would say, as an engineer as well as an individual, that it was highly unsafe?

Captain ALBERS. The tower was in danger of collapse if hit by a storm of sufficient size.

Senator STENNIS. If hit by just an ordinary winter storm; it would not have to be a September hurricane of Donna proportions. Is that not correct?

Captain ALBERS. Well, it went through a pretty good storm, as I understand it, in December; what I would call an ordinary winter storm it went through in December and it suffered additional damage, but it did not fall down.

Senator STENNIS. And this storm that finally took it down was not of Hurricane Donna's proportions, as I understand. It was just another winter storm, is that correct?

Captain ALBERS. That is my understanding. The only description I have seen is from the Air Force and that said it was of gale proportions.

Senator STENNIS. I believe that is all I have.

Thank you again, Captain.

Counsel may have something.

Mr. KENDALL. I am a little confused about how much significance you attached to the loss of the diagonals during the tow and the necessary replacement of them. Do you view that as the beginning of all the troubles and directly contributing to the resulting difficulties?

COLLAPSE OF TOWER TRACEABLE TO INITIAL LOSS OF DIAGONAL BRACES

Captain ALBERS. I do think that the difficulties they encountered in installing that brace did contribute to the other difficulties, and eventually to the failure of the tower.

Senator STENNIS. Which brace, Captain?

Captain ALBERS. These two braces were lost, and they had to be installed with a fitting that was installed under water, which I believe was designed correctly and every effort was made to install it correctly. But it was not installed correctly because some of the pins came out and it became loose.

Mr. KENDALL. In other words, that was sort of the point of no return. Someone had to make a decision then, either to erect it and

try to repair it under water, or take it back to port and complete the repairs in the docks; is that correct?

Captain ALBERS. That is right.

Mr. KENDALL. What difficulties would they be faced with in repairing it under water that they would not be faced with in port?

Captain ALBERS. In the first place, they had to change the design of the joint to connect it to a band rather than to plates that were welded into the top.

In the second place, it all had to be done by divers, rather than men working in the air.

Mr. KENDALL. Was it necessary to give any increased tolerances for the pins as a result of this?

Captain ALBERS. I do not think so, and I do not know that any was.

Mr. KENDALL. About the X-braces, Captain, was not the installation of X-bracing considered as part of the original design process?

Captain ALBERS. That is correct, sir.

Mr. KENDALL. And it was rejected?

Captain ALBERS. It was rejected because we were concerned with how we could keep them from corroding under water. We were endeavoring to make a more permanent structure.

Mr. KENDALL. I have one further question that is really for clarification. You testified I believe, that the legs were fractured above the caissons?

Captain ALBERS. That has been my understanding.

Mr. KENDALL. Well, we need a little definition on the term "caissons." We have been referring to the caissons as the entire leg?

Captain ALBERS. The caisson was the enlarged portion of the leg that was in the ground.

Mr. KENDALL. That is what we have been referring to as the footing, I believe.

Captain ALBERS. That is correct.

Senator STENNIS. That was put in after you got the tower in place, was it not?

Captain ALBERS. No, sir. That was part of the leg and was sunk down into the bottom.

Senator STENNIS. It went in though, as part of the leg, the interior part?

Captain ALBERS. It was the bottom part of the leg—actually it is exterior. It is much bigger than the leg itself.

Senator STENNIS. I see. But it was actually a part of the leg?

Captain ALBERS. That is correct.

Senator STENNIS. I did not understand that.

What was that you said a while ago when someone interrupted you? You said you were told that all of the braces were torn loose. I suppose, if I heard you correctly, you meant after it collapsed, and as it was found later?

Captain ALBERS. When this diagonal was broken, as I understand it, you had no effective bracing system left on this side of the tower.

Senator STENNIS. Now, you have pointed in your answer to the bottom bracing, the one that is marked. You pointed to that, did you not?

Captain ALBERS. That is correct, sir.

Senator STENNIS. I want the record to reflect what you were pointing to.

Captain ALBERS. The lower diagonal brace.

Senator STENNIS. The lower diagonal brace on that particular leg?

Captain ALBERS. The one that was reported broken on January 6.

Senator STENNIS. Is that when they first found it?

Captain ALBERS. That is when it was reported broken.

Senator STENNIS. Now, at that time, that meant that other braces above that one were broken. Is that right? Did you say that?

Captain ALBERS. These are the ones, as I understand it. Two of these had been broken during Donna, and I understood that this had been broken after Donna. It says so.

When you break one member of this assembly, you lose most of the effectiveness of the four members.

Senator STENNIS. To be certain now that I understand you, so far as that pier is concerned, when it was discovered that the bottom brace was broken, that meant that the other braces were ineffective?

Captain ALBERS. You have very little strength for a force applied in this direction.

Senator STENNIS. You mean as far as that pier is concerned?

Captain ALBERS. Both this pier and this one?

Senator STENNIS. Is that so? Well, if there was no bracing at all as far as that pier was concerned, from that direction, it left it in almost the same situation as your other towers, where you just had the pier standing there unbraced. Is that right, sir?

Captain ALBERS. Yes, that is correct, but these legs were not designed for that, sir.

Senator STENNIS. I know they were not. And tower No. 4 at that time had the added burden that the resistance of the X-bracing would still present to waves?

Captain ALBERS. That is right, sir. I am sure they knew they were in very critical condition when this material was broken. I am sure they knew they were in critical condition after Donna, when just two of them were broken.

Senator STENNIS. So from September 1960, at the time of Donna, until it collapsed, in your opinion, they were in critical condition?

Captain ALBERS. That is correct, sir.

Senator STENNIS. I think your opinion is very worthy, as a professional engineer, and your frankness is very valuable, and very sincere. You are to be commended, sir.

Captain ALBERS. Thank you.

Senator STENNIS. Any other questions?

Mr. KENDALL. No, sir.

Senator STENNIS. Is there any other testimony this afternoon?

Mr. KENDALL. No, sir.

Senator STENNIS. Captain, I regret very much that I was away when your testimony commenced. It was certainly not any lack of appreciation for you and your staff.

Captain ALBERS. These are not my staff, sir. They are here to keep me out of trouble.

Senator STENNIS. All right.

There is an old saying that you should not ever interrupt a man, Captain, while he is paying you a compliment. I was trying to compliment you and those who were with you.

I shall certainly read all of your testimony that I did miss because of the fact that I had a personal matter to attend to. I want to thank you again, and the gentlemen that came with you.

May I ask one thing further, Captain?

Sometime during these happenings, you went to another post. Just when was it you left? I did not understand that.

Captain ALBERS. The 1st of January 1957.

Senator STENNIS. The first day of January 1957?

Captain ALBERS. Yes, sir.

Senator STENNIS. Then you had no duties in connection with the tower when it was turned over to the Air Force in November 1957?

Captain ALBERS. That is correct, sir.

Senator STENNIS. Who succeeded you?

Captain ALBERS. Commander Foster.

Senator STENNIS. He will testify some time during this hearing, I believe.

We are in recess, then, until 10 o'clock tomorrow morning, gentlemen.

(Whereupon, at 5:33 p.m., the committee recessed, to reconvene at 10 a.m., on Thursday, May 4, 1961.)

INQUIRY INTO THE COLLAPSE OF TEXAS TOWER NO. 4

THURSDAY, MAY 4, 1961

U.S. SENATE,
PREPAREDNESS INVESTIGATING SUBCOMMITTEE
OF THE COMMITTEE ON ARMED SERVICES,
Washington, D.C.

The subcommittee (composed of Senators Stennis (chairman), Symington, Bartlett, Jackson, Bridges, Saltonstall, and Smith) met, pursuant to recess, at 10:35 a.m., in room 235, Old Senate Office Building, Senator John Stennis, presiding.

Present: Senators Stennis (presiding), Symington, Bartlett, Jackson, Saltonstall, and Smith.

Staff members, Preparedness Investigating Subcommittee: James T. Kendall, chief counsel; Stuart P. French, professional staff member.

Senator STENNIS. All right, the subcommittee will come to order.

I know we will have the cooperation of everyone in being as quiet as the circumstances permit, so that all can hear.

Not by way of complete review to all members of the committee, but I think we had some very important and very illuminating testimony yesterday which, in very brief substance, showed some very fine work by the Navy, I thought, and the manufacturer. But at the same time, it showed that this most unfortunate tower, even though it was not born with a defect, it nevertheless had a defect in it at the time that it was erected. The broken structure started a series of events that worsened rather than improved and finally led to its destruction.

Now, this morning we have Mr. DeLong and Mr. Bauer—and you, sir, are the counsel?

Mr. INGOLDSBY. Mr. Chairman, I am John L. Ingoldsby. I am counsel for the DeLong Corp. This is Mr. Rand, an associate counsel.

Senator STENNIS. All right. Let me say this, members of the committee. I have not talked to Mr. DeLong, who is going to testify first. We are not requiring anyone to testify to matters that might impose any legal liability on them in any way in connection with these hearings. I have advised Mr. DeLong to that effect. We are not looking for someone to punish nor for someone to blame. This committee is solely interested in the strength of our military program. We are interested in the dollars that we have authorized and appropriated for these purposes. All else is incidental. All else falls by the wayside. We do not expect to be deterred from following through on this point.

Again, for emphasis, we do not propose to go beyond January 12, which was the day that things finally came to a head and when a conference was held with reference to this structure and its approximate

strength. We are cutting off, as best we can, at that point. What happened thereafter involves directly command responsibility. Charges have already been preferred against some of the officers of the Air Force. They will be disposed of in another forum. We are staying out of it as that is for the determination of another court. However, I do think that the background of the facts we develop here will help justice be done there, substantially help it, and not hinder it in any way.

Now, those of you who will testify, please stand.

Do you, and each of you, solemnly swear that your testimony in this hearing will be the truth, the whole truth, and nothing but the truth, so help you God?

Mr. BAUER. I do.

Mr. DELONG. I do.

Mr. KENDALL. Mr. Chairman, Mr. DeLong and Mr. Bauer are both here by virtue of subpenas of this committee. Their counsel have requested that they be permitted in advance of the testimony to make a very brief statement for the record, and I would like to recommend that they be given that privilege.

Senator STENNIS. All right. We recognize you as counsel for Mr. DeLong.

Mr. INGOLDSBY. For the DeLong Corp., Mr. Chairman.

Senator STENNIS. You will have to be sworn, too, if you are going to make a statement. That is our invariable rule. Do you solemnly swear that your testimony before this committee will be the truth, the whole truth, and nothing but the truth, so help you God?

Mr. INGOLDSBY. I do.

Senator STENNIS. All right.

TESTIMONY OF L. B. DeLONG, PRESIDENT; GEORGE BAUER, VICE PRESIDENT IN CHARGE OF CONSTRUCTION; JOHN L. INGOLDSBY, COUNSEL; BERT B. RAND, ASSOCIATE COUNSEL, DeLONG CORP.

Mr. INGOLDSBY. Mr. Chairman, and members of the committee and committee counsel, Mr. DeLong and Mr. Bauer are officers of DeLong Corp. and are here pursuant to subpena. A subpena was also issued to Mr. George E. Suderow, chief engineer of DeLong Corp. It is with great regret that we must inform the committee that Mr. Suderow died of cancer last Saturday, April 29. By subpena Mr. DeLong and Mr. Bauer have been required to produce certain material from their files. Although this requirement was made on only a few days notice, these gentlemen have complied to the best of their ability. If any additional documentation specified by the subpena is found, it will be delivered to this committee.

DeLong Corp. is an engineering and construction company specializing in design and construction of marine platforms, docks, and similar structures. This company has pioneered the design and erection of marine platforms for use throughout the world and has engineered, constructed and operated offshore drilling platforms in remote parts of the world as well as in the Gulf of Mexico. The name, DeLong Corp., has become closely identified with the generic name of Texas towers.

The DeLong Corp. erected Texas tower No. 2 which now stands in the Atlantic Ocean off Nantucket. This was the first radar warning

platform erected. The DeLong Corp. was an unsuccessful bidder for the construction of Texas towers 1, 3, and 4.

We understand that this committee's investigation principally involves the tragic collapse of Texas tower No. 4. The DeLong Corp. had nothing to do with the design or erection of this platform, either directly or indirectly. Unfortunately, since the DeLong Corp. is preeminent in this field, there has been considerable confusion in the public mind as to its responsibility, if any. Business concerns, commentators and others, both orally and in writing, have assumed that the DeLong Corp. designed or erected the now collapsed Texas tower No. 4 despite the fact that it was in no way involved. This has created some serious business problems for the DeLong Corp.

While the DeLong Corp. and its officials will comply fully with the subpenas of this committee, they are gravely concerned that the public may receive the impression from the fact that the committee has required their presence here, that they are in some way responsible for the disaster which occurred in January.

It is, therefore, respectfully requested that the committee recognize on the record that the DeLong Corp. was not directly or indirectly involved in the design or erection of Texas tower No. 4.

Senator STENNIS. Well, you have prepared a good statement there. I think that is well for the record. The committee cannot reach any conclusion, of course, until the facts are in. The facts will speak for themselves.

All right. Mr. DeLong, you have heard the preliminaries here. You understand the situation. You heard the testimony yesterday, did you not?

Mr. DELONG. Yes.

Senator STENNIS. I understand you do not have a prepared statement. But I am going to ask you to make a general statement now covering all the facts and the developments with reference to any discussions you may have had, conferences you had about the design for Texas tower No. 4, or any other one of these towers. To make it specific, I will just put it this way: Prior to November 1, 1955, did you or your engineer discuss with Captain Albers or with the designers and architects, a method of design and construction of Texas tower No. 4 substantially different from the method that was actually followed; and if you did, give us the outline, fairly briefly, of those discussions and the engineering principles involved. We are concerned here with the soundness of design.

Mr. DELONG. Mr. Chairman, we had some discussions with the design engineers, with the Navy, Captain Albers, and they were in the main part handled by our chief engineer, Mr. Suderow.

DISCUSSIONS ON FEASIBILITY, 1954

We were called in, in the early stages of 1954, to discuss the feasibility, or whether it was possible to build towers such as——

Senator STENNIS. Pardon me, now. Mr. Suderow is the gentleman who passed away?

Mr. DELONG. Yes, sir.

Senator STENNIS. All right.

Mr. DELONG. To build towers in the Atlantic—and we so advised the Navy that we thought it was feasible. Then in the latter part

of 1954, and the early part of 1955, about December and January, we were called in and advised that the design engineers had come up with a scheme, and would we look at it with the purpose of erecting it. We did. And we said, "Yes, the scheme is all right, we go along with it, subject to certain changes and we would like to discuss them. over a series of conferences." The first tower, No. 2, had bracing in it. We objected to the bracing. Our experience had given us the knowledge that the tower could be built differently, without bracing, by reinforcing the legs, restudying the bottom condition, and putting your penetration into the ocean floor to such depth that you had what we call fixity at this point and up here, and the column was strong enough to withstand the sea action. Your brown mark, is where the ground line on the ocean floor starts. That was agreed on as being around 50 feet. The legs were stiffened up, steel was made thicker, and bracing was eliminated. The use of bracing was a serious objection on our part. But the engineers, the design engineers, were very cooperative and everybody put their best effort forth to come up with the solution.

Senator SALTONSTALL. Mr. Chairman—did you say 50 feet in the ocean floor?

Mr. DELONG. It is 48 to 50 feet—into the ocean bed. The ocean bed is actually here.

Senator SALTONSTALL. Is that rock or sand?

Mr. DELONG. Sand.

Senator STENNIS. Mr. DeLong, it will make it clearer for the record and also for those present if you will make it clear that you are pointing to the model before you.

Mr. DELONG. Yes, sir.

Senator STENNIS. That model has three legs without any bracings?

Mr. DELONG. That is correct.

Senator STENNIS. That is the model for tower No. 2?

Mr. DELONG. Yes, Texas tower No. 2.

Senator STENNIS. It will be better, when you say "here" if you will indicate that you are pointing to the brown part, the lower part. Remember that as best you can.

Mr. DELONG. Yes, sir. The reason that I go back on tower No. 2, is because some of the principles of tower No. 2 go over into tower No. 4. It was also decided that a 10-foot diameter leg was sufficient strengthwise, but that the portion that would go into the ocean floor—that is the brown portion—should be larger, and that was increased to 15 foot diameter.

WATER DEPTH IS DECIDING FACTOR IN USE OF BRACING

Then there was considerable concern about erosion—sand cutting away the steel and so forth. Therefore, it was left approximately 15 feet, I believe, above the ocean floor, the same diameter, steel and concrete and so forth, to provide for erosion or sand scour over a period of time, which could wear the steel away and things like that. But when you get to a certain stage of water depth, this freestanding column is inadequate, and roughly the rule of thumb, is that of about 100 feet—taking into consideration the conditions that you have in the Atlantic, the storms, the sea and so forth, that you have to cope with. So, therefore, when you get to a hundred feet or over, you have to do something else, for example, use bracing.

Now, the theory of Texas tower No. 2, and the theory from the ground line up, or from the storm line, where the bottom of the ocean waves work, is not to have any more obstruction than you absolutely have to have. Therefore, it is very essential—that is a principle you design on, and the Texas tower No. 2 was designed on that principle.

Senator STENNIS. Pardon me. The reason appears obvious, but you might state it anyway. What was the reason for that?

Mr. DELONG. Because if you put bracing in, you will generate the additional resistance against your structure from the ocean waves. Therefore, you want to at all times let the water flow with a minimum of resistance. So therefore, you can only go to depths of water of about 100 feet. After that the size of your column, we will call the legs columns, become so large it becomes uneconomical.

Then, since you have an ocean floor here, which was roughly 56 feet below the water, and you had to accept that and design for it, then you take your next step, where your water is deeper, and in this case tower No. 4 was estimated at 180 feet and it wound up in the end 185 feet, but it is pretty difficult to get the water depths exact out there in the ocean, and we make that mistake every day where we are off a few feet.

So when the design of tower No. 4 was discussed with us, it appeared the only logical design in deep water that, figured costwise and strengthwise, was the K-brace design that tower No. 4 was built on. There were other things that we disagreed with and so forth. But the K-brace structure, as it is known, triangle K-brace structure, is the best known method of construction, because when you go into the deep water you start assuming another line of thinking. You say—all right, my ocean floor was minus 56 feet for the Texas tower No. 2 design. Now I have to make a new ocean floor, and that is actually what you are doing with the triangle K-brace structure. You make a new ocean floor. So you say to yourself, where am I going to make this new ocean floor?—because you want to remember now on this one the criteria was, and the assumption or the basic rule was to leave the bracing out of the water motion zone. So then you automatically come to an answer there. We have to keep our bracing below any wave action. That was done. The assumption was made correctly, minus 25 feet or 27 feet. That was proper design.

Senator STENNIS. Below the water?

Mr. DELONG. Below the water.

Senator STENNIS. All right.

Mr. DELONG. Now, this became your new ocean floor. Visualize it as your new ocean floor. Now, what you build here had to be just the same as the ocean floor. It had to be a rigid, fixed structure without any possibility of movement, because from here up you follow the same principle except that you have a manmade ocean floor which was now minus 27 feet. Therefore, you could lighten up some of these members that went on top here and not design them exactly as heavy as they were here where your water was deeper. And that was done.

Senator SALTONSTALL. Mr. Chairman, if Mr. DeLong is through——

Senator STENNIS. No, he is not through, that is I do not think he is through. You may ask a question anyway for clarification.

Senator SALTONSTALL. My question is this, Mr. DeLong. You said you went down 50 feet on the embedment for tower No. 2.

Mr. DELONG. Pardon me, sir—48 to 50 feet.

DISPARITY IN EMBEDMENT

Senator SALTONSTALL. All right—48 feet. Now, we had testimony yesterday that on Texas tower No. 4, they only went down 20 feet.

Mr. DELONG. It was 18, sir.

Senator SALTONSTALL. Yes, actually 18 feet although the original design called for 20 feet, I believe. There is a discrepancy of 28 feet—call it 30 feet. Now, if the water is deeper at Texas tower No. 4, and they only went down 18 feet, and yet you went down 48 feet on Texas tower No. 2 why didn't they go down deeper on tower No. 4, particularly if you have a new floor as you have explained it?

Mr. DELONG. We don't know enough about that. Moran, Proctor, Mueser, and so forth are probably the foremost foundation engineers in the world. I am not in a position to make a statement that it is enough or that it is not enough. I will say this; that when we knew and heard just recently that it was 18 feet, it was a surprise. But I would not——

Senator SALTONSTALL. What was that?

Mr. DELONG. It was a surprise. But I would not be in a position, nor would I want to criticize Moran, Proctor's assumptions on that footing.

Senator SALTONSTALL. All right. Now, the second question I have, in that same connection: At what depth of water do you start making this second floor that you are talking about, where these K bracings are necessary?

What was the depth of the water?

Mr. DELONG. 185 feet.

Senator SALTONSTALL. All right. The depth on tower No. 2 was what?

Mr. DELONG. It was 56 feet.

Senator SALTONSTALL. All right. Now, at what depth do you find it necessary to put in the K-bracing?

Mr. DELONG. In a K structure, the first bracing, a triangle K structure, as we call it, your first bracing always starts where you are going to land on the bottom—right at the ocean floor. You are supposed to start your first bracing there.

Senator SALTONSTALL. I have not made my question clear. There is 185 feet of water at Texas tower No. 4. There is 56 feet of water over there at tower No. 2. Now, if you were building the tower at, we will say, 100 feet of water instead of 185 feet, would you put in the K-bracing?

Mr. DELONG. I do not believe at 100 feet. Over a hundred feet we would start.

Senator SALTONSTALL. Over 100 feet?

Mr. DELONG. Yes. I am quite sure we would.

Senator STENNIS All right. That is clear. That is a good question——

Mr. DELONG. It depends.

Senator STENNIS. Continue with your story, Mr. DeLong, and point out those things which you think are pertinent. You are making it very clear, so just take your time and tell us the whole story. I understand it will take you some 30 minutes or more, but that will be all right.

Mr. DELONG. Now, since you have established this level as your ocean floor—that is what the theory is, and what you are trying to do.

Here is your waterline—the blue marking into the gray is your waterline. So you have to think of the same problems that you have had over here when you decided to go 48 feet into the ground and had 15-foot-diameter enlarged lower cylinders, for the ground portion. You have the same problem, because you have the same sea action. You still have the sea. This is your new ocean floor.

NEW FLOOR JUST BELOW WAVE ACTION

The stresses that you have here, less the water depth—you have 25 feet here, so you have a smaller action floor to work on. You have made it the best that you could, since you are making a new ocean floor, always remembering that you had to put these bracings here below the movement or the bottom of the wave to keep the resistance of the legs against the sea down to a minimum.

Now, it became very important, then, that from here down this structure was of sufficient strength and was anchored in the ocean in such way that it would act as it was—for it was designed as an ocean floor up to here about 150 feet or something like that.

PIN CONNECTIONS CONSIDERED POOR DESIGN

We disagreed with pin connections because——

Senator SALTONSTALL. Would you repeat that, please?

Mr. DELONG. We disagreed with pin connections—pin connections.

Senator STENNIS. You mean you advised against the use of pin connections?

Mr. DELONG. I would make it a little stronger. We just stated positively that we did not want any part of it, any part of it.

Senator SALTONSTALL. Mr. Chairman, would you be willing to let me ask a question on that point?

Senator STENNIS. Oh, yes; yes.

Senator SALTONSTALL. I want to get this question of erosion very clear, Mr. DeLong. Now, you said that column was made 15 feet in diameter at that level, because of the danger of erosion. Now, am I correct in believing that salt water causes erosion on steel, and if you have two steel joints coming together such as these pin connections then the size of your lower structure—what do you call that—pole or what do you call that thing—a leg?

Mr. DELONG. Leg.

Senator SALTONSTALL. Is it not true that salt water causes erosion where steel meets steel? Am I right on that?

Mr. DELONG. Well, there are various ways of taking care of that, Senator. You can use cathodic protection under water and above water you can paint. Erosion, I think, has been used in a different term here. Erosion is something caused by the elements, water and so forth.

Senator SALTONSTALL. But if you have a steel anchor cable, and you connect that to a chain with a link, there will be erosion between that steel cable and the iron chain connection in a year, will there not? Now, that is caused by salt water.

Mr. DELONG. Well, salt water causes erosion.

Senator SALTONSTALL. Well, what I am getting at is that you built the leg 15 feet in diameter to avoid the effect of erosion, didn't you? That is what you just said.

Mr. DeLong. I would like to correct the record. It was designed by the design engineer—how much we had to do with going to 15 feet. But when we all discussed the problems, it came up with a 15-foot diameter, and the erosion that we were talking about, Senator, is the movement of the sand across the banks. And it works on the same basis. If you have seen sandblasting—somebody sandblasts steel or the face of a building.

Senator Saltonstall. All right. Now let's get back to the pin. You said you would not have anything to do with pins, didn't you?

Mr. DeLong. For the——

Senator Saltonstall. In fastening.

Mr. DeLong. For the following reason. You have a pin in here. You must have some slack to insert the pin. Then when the sea works on the tower, this pin is doing this, and the impact of it is next to impossible to figure.

Senator Saltonstall. Well, I do not want to delay the chairman. Then the fact of whether you put in a pin or did not put in a pin had nothing to do with the working of salt water on that metal.

Mr. DeLong. No; no, sir.

Senator Saltonstall. Nor its magnetic attraction to the other metal?

Mr. DeLong. No, sir.

Senator Saltonstall. That had nothing to do with it?

Mr. DeLong. No, sir.

Senator Saltonstall. I just happened to know that because we almost lost a boat due to the erosion between a steel anchor line and the iron chain connection, which eroded in 2 or 3 months.

Mr. DeLong. Electrolysis.

Senator Saltonstall. What?

Mr. DeLong. They call it electrolysis.

Senator Saltonstall. Yes. And that had no effect on the pin connections?

Mr. DeLong. I do not believe that that had anything to do with the tower. You can make provisions——

Senator Saltonstall. Thank you.

Senator Stennis. All right, Mr. DeLong. Thank you, Senator.

Mr. DeLong. It was merely a different opinion that we, in our experience, did not want any possibility of a pin connection and having a clearance where it would move. And we only saw it one way—as a completely welded structure, because this is your ocean floor—from here down, and you had to eliminate movement.

Senator Stennis. All right, proceed now in your own way. You are making this very clear, and it is extremely interesting.

Mr. DeLong. So our opinions varied on pins versus welding.

OBJECTION RAISED TO USE OF KUSS METHOD OF ERECTION

Our next problem in our discussions—we saw extreme hazards and no way of calculating the stresses that would be put on the structure and the tilting action, and also the possibility that one leg could hit first in the ocean in a storm, and the additional stresses. We just notified all the people interested that we would not go along with it. And our chief engineer advised us that he had worked out a method that was acceptable, that we could use a method which was acceptable to us. That is what we call scheme B in the book which

kept us from tipping the structure and which let us weld the structure. And then we proceeded from there on in our thinking just the same as the rest of them.

Now, the testimony yesterday gets a little confusing as to what condition the tower was in or what happened to it. But I will cut all through that, and go to the last stage.

Now, remember, the theory that this tower was designed on, was minimum resistance to the ocean waves. And as this tower started to——

Senator STENNIS. If the members of the committee will excuse me for interrupting, it appears that your explanation of scheme B would be very pertinent right at this point. You have led up to that proposal, and there was testimony about it yesterday. Would it suit you to describe scheme B now?

Mr. DELONG. Mr. Chairman, I would like to turn scheme B over to Mr. Bauer, because he should earn his pay, too.

Senator STENNIS. Very well, proceed in your own way. You may proceed with your testimony now.

Mr. DELONG. I will go a little farther, if I may.

Senator STENNIS. You go on.

ABOVE WATER "X" BRACING INSTALLED IN DESPERATION

Mr. DELONG. As the trouble developed, and in, I call it, a desperation move, the top bracing was put in. Remember, now, that it is contrary to the whole design and theory, because here is your ocean floor and your bottom column, and your sea is supposed to come through. So that—when that was done, I would feel that it was pretty close to dooming the tower. And I am very surprised that the tower stood up through Donna at all—that it did not go down completely.

Mr. Chairman, I would like to say this—that in engineering and so forth, it is like horseracing. There is a lot of difference of opinion. We, in our experience, disagreed with the design engineers and so forth. And we said where the mistake was—but the course was taken, and we feel a little to blame that we were not able to marshal our arguments over clearly enough to get it changed. Had we done so, we feel—had we done a better job of presenting our arguments and so forth, we might have been able to avoid a disaster. But we were not, and we blame ourselves for not being able to convince the people in regard to pin versus welded connections.

Senator STENNIS. Well, that is a very fine attitude and a frank statement about it. It impresses the Chair.

Does that cover the high points of your statement?

Mr. DELONG. Yes, sir; that covers my high points.

Senator STENNIS. We can ask questions later. To get the entire matter before us here, what does counsel propose—that we now hear from the other gentleman as to scheme B?

Mr. KENDALL. Yes, sir; that is my recommendation.

Senator STENNIS. Counsel is very familiar, as Mr. French is, with all these matters. It has taken weeks to get the testimony together.

Without objection, then, we will switch over now to Mr. Bauer. What is your connection with Mr. DeLong, please, Mr. Bauer?

Mr. BAUER. Mr. Chairman, I am vice president in charge of construction for the DeLong Corp.

Senator STENNIS. All right. Do you wish to proceed now with a description of scheme B, and whatever other major points you have in mind? You may proceed in your own way.

DESCRIPTION OF SCHEME B METHOD OF CONSTRUCTION

Mr. BAUER. Scheme B is the method that the DeLong Corp. had anticipated using in putting this tower up when we submitted our bids. The lower part of the tower, tower No. 4, as we visualized it at that time, would be constructed almost identical with this model here.

This would be a rigid construction, from this elevation here down. And this would then become the ocean floor, as Mr. DeLong pointed out.

Senator STENNIS. For clarification only, you are pointing to the model of tower No. 4.

Mr. BAUER. Yes, sir; that is correct, sir. The main difference in the construction would be that this lower portion of the tower, this rigid K bracing and the three legs, would be constructed in a vertical position. It would never be in a horizontal plane and tipped up on the site. It would be constructed and floated in a vertical position with the finished elevation just above the K bracing. The template. as we call that part of the tower, would then be floated out on the location, and set down on the bottom of the ocean, which would mean that the tops of the legs here would be under water from 30 to 50 feet, and all of the bracing would be below the wave zone.

However, our method then would have been to bring out a small, temporary three-cornered platform, with caissons, with jacking caissons floated over the templates. The caissons lowered down into a sleeve on the template, and the work platform, as we call it, would be jacked clear of the water. This is a very light platform, in the vicinity of 400 tons, instead of the 4,000 tons that is in the permanent platform. After we got the work platform up off the water, and out of the sea, we would start with the excavation of our footings on the main template. We would sink the footings, and at that time the specifications called for driving a number of pilings down through the footing to a 50-foot penetration, to obtain the fixity of the template at the bottom of the ocean.

After the template was alined and fixed permanently to the bottom, then the small temporary work platform would be floated off and the permanent platform, the finished top, 4,000 ton platform, would be floated over the top of the fixed template. jacked clear of the water and welded off. The complete operation would be rigid and completely welded. There would be no slack or play, no bolt connections of any kind.

That was our method at that time. And I think that finishes scheme B.

Senator STENNIS. Did you hear the testimony yesterday, Mr. Bauer?

Mr. BAUER. Yes; I did, sir.

Senator STENNIS. For contrast and clarification, even though it may be repetitious, just contrast what you have described with what was actually done. I think I know, but some could not be here during all of the testimony. You have described what you would have done. Now tell us what method was used.

Mr. BAUER. I would rather Mr. DeLong would do that, because——

Senator STENNIS. All right.

Mr. BAUER. May I explain that at the time we went through the method of our construction here, I was engaged in building Texas tower No. 2; I was absent most of the time.

Senator STENNIS. All right. Mr. DeLong make that contrast for us.

Mr. DELONG. The tower, as it was constructed, had some changes.

DEVIATIONS FROM ORIGINAL DESIGN CAUSE SERIES OF CHANGES

The original tower design had a large diameter what we call pan below, through which, from above the water, you drove piling into the ocean floor, and that was a steel structure, the pilings were driven through, then concrete was tremied, underwater concrete, around the piling so the tower was fixed to the ocean floor. The design, as it was laid out, had a small platform, what we call a temporary platform, designed to go out with the structure and upend, so they could then drive their piling—this is the method that we were against, and as Mr. Bauer explained. But after the contract was let, like every contract, people get together and discuss their problems and ways and means of trying to improve the doing of the job. The theory was advanced that the ocean floor was of such material that if they picked something like a 25-foot diameter base, 20 feet deep, and sank it that far into the ground, that it would be a stable structure. And they proceeded on that basis. They made the design changes, which is normal when you start to talk about the problems, and this was done. Again, I say, I do not know from what limited information we have whether it was sound or not, because we assumed that it was because the people that agreed to it—Moran, Proctor—have done many foundations.

Then the next change came when the temporary platform was eliminated which, as this structure upended, was supposed to come up with it. It was a light structure—because the template then would sit on the ocean floor, and if it sat unevenly or something like that, you would want a light weight up here. That is the reason that we came in with a light template originally on our submerged structures, because we wanted a light weight, we did not want to stress the members any more than they had to be stressed.

So they eliminated that. Evidently, everybody was in agreement, which is again done every day in trying to work out problems between the contract officer and the engineers and the constructor.

But when they eliminated this, they went to the next step. And here is where, like one step leads to another. They decided to bring the main platform in, as the motion picture shows, after the structure had been tipped up, and it was so testified yesterday that it exceeded 4,000 tons. I think our computations at the time, when we objected to the method and said it would be very dangerous to bring the structure—the permanent platform in, even after the legs were fixed—that you would be at the mercy of the sea and a squall or a little storm could come up and you would break up your legs, and just be in trouble. And as the record showed yesterday, it took them 12 hours in which to make the connection. We feel that you are exposed too long to the mercy of the sea in doing that, and you can get in trouble.

So when the decision was made to use the big work platform and eliminate the small platform, and add 20 feet down below that was going to be sunk into the ocean floor after it was upended, it created a problem because then the bracing which was 25 feet—I believe I am right—25 feet below the water level, 20 feet added on here, plus the draft of the big platform, it was impossible to float it over this tier of bracing. Therefore the next change was made. That was the elimination of this tier of bracing.

Senator STENNIS. Where you are now pointing?

Mr. DELONG. Yes, sir. Take this brace out, and fold these down, so that they would have clearance in which to come in with the large barge.

Now, one of the things that we particularly objected to was the stresses that would come on this tower when it was turned over with all the bracing in. Now, this had a portion removed, and whether it reduced it one-third or not, I would not know, but it made a substantial difference in the stresses that would go on the other two tiers and the remaining members. So the situation, in our estimation, was considerably worsened, if I may use that word.

The structure then was floated in and the attachment was made. And in the original design, prior to floating in the main platform and connecting it, with the structure being fixed in the ocean floor, concrete was to be put in around the water line reinforcing it so if the barge hit the legs and so forth they would not cripple, what we call cripple, cave in or something like that. But the method that was followed eliminated the concrete because it could not be put in until after they had the big barge up—that is, the big platform.

So you have the unbraced, nonreinforced portion at the waterline. You had also taken out a series of bracing here. So your arm, as your platform was working in the sea, you were working from there down to the second tier of bracing. And where the damage was done, what it was like, what members were overstressed, I would not know. And it would be hard to tell. You can only tell if you have a fracture, but you can't tell if you are overstressed, because your steel doesn't show it until it breaks. And what overstressing was done in the turning up, with the members out and so forth——

Senator STENNIS. Right at that point, please point out the braces that were broken when the tower was erected. I think the markers show on the model. Well, perhaps markers don't show it. Do you know from information which braces were broken in the operation of erecting the tower?

Mr. DELONG. We understand that the horizontal member was removed and brought out separately. The diagonals were laid down and lashed, but still pinned on the leg end. We understand that the lashing gave way, and that started another chain reaction causing this pin and that portion which fastened to the leg to break out—just tore it loose from the leg.

Senator STENNIS. While you are on that point, is it true that the horizontal braces that you have been referring to as having been removed before the tower was upended, were later restored?

Mr. DELONG. That bracing was put back in.

Senator STENNIS. Put back in.

Mr. DELONG. But another thing that happened—the diagonal which is hard to understand why it was not taken off completely and

replaced the same as the top one, but they probably figured that it would be easier to lash it and bring it back up. But the lashing gave way. And when those diagonals tore loose, they did damage to the connections to the leg. To repair that under water brought on problems, and I agree with Captain Albers that after the repair, you were in serious trouble. I believe that is what Captain Albers testified.

Senator STENNIS. That is what he said.

Mr. DELONG. And the repair here never did hold. Whether it was improperly designed or improperly installed—when you get into a position like that, I can only say you are in serious trouble.

DANGER POINT ESTABLISHED

Senator STENNIS. Well, if the committee would permit me—and some were not here yesterday and that is the reason I go over this—in attempting to repair the damage done at the time of the upending, is that when the Dardelet bolts were installed? I understand that it is at that point you say that they were in trouble, that the repairs were difficult, and that from that point on, the danger was there. Is that correct?

Mr. DELONG. This was one of the problems that we visualized that could happen to us, and I think somebody had a decision to make, when you found that the braces tore loose, as to whether you should go back to the port and repair——

Senator STENNIS. Now, that is my real question. You are a qualified man on this very difficult matter. Faced with the facts as they existed then, what would you have done?

Mr. DELONG. Well, I would probably have perspired a little.

Senator STENNIS. In addition to that, what would you have done?

Mr. DELONG. It depends upon how the break was. I would not venture to say that I would take it back because it was a horrible decision that had to be made, and I give thanks that I did not have to make it. I do not know.

Senator STENNIS. To have returned it to port would have been the way to have completely repaired the damage, isn't that right?

TO ACHIEVE ORIGINAL STRENGTH, REPAIR WOULD HAVE TO BE MADE IN PORT

Mr. DELONG. To restore it to its original state, you could only have done it by bringing it back to the port.

Senator STENNIS. That is the point I was going to inquire about. Was there any way to restore it to its original strength without taking it back to port?

Mr. DELONG. In my opinion, there was not. To restore it to its original state, you would have to take it back. They were working under water and using Dardelet bolts and things like that are all temporary repairs. We use them in temporary repairs and work like that.

Senator STENNIS. All right, you proceed if there are other points in connection with that question which you want to discuss.

Mr. DELONG. No; I just think that, listening to the testimony and what we know of it, this probably, if there were other fractures or anything loose, was one of the main contributing factors for it to

deteriorate so quickly. Because if these collars that they put on did not hold, then the whole structure was working and the sea continually worked on it. Because there is one thing we can all be sure of, the ocean is not going to get tired. You will get tired or metal or anything else will tire before the ocean will get tired. That is just the problem you had, it worked on it and——

OTHER CONTRIBUTING FACTORS

Senator STENNIS. So that from that point on, it appears, trouble followed on the heels of trouble, so to speak, until the final culmination and collapse. Were the use of Dardelet bolts, and the fact that you had pin connections rather than welding, other contributing factors?

Mr. DELONG. The pins in the ultimate would cause trouble, because, as I say, the sea works on it at all times, causing an impact at the clearance. The original clearance, I understand, was one sixty-fourth. I do not know whether that was enlarged or not, but even at one sixty-fourth, we were absolutely against it. We are against pin connections in the ocean, and if the tolerance, as we call it, was increased, it aggravated the situation, or would aggravate it, that much more.

Senator STENNIS. The next added burden which was imposed on the tower was the addition of above-the-water bracing, is that correct?

Mr. DELONG. This was contrary to the entire theory of the platform design and construction.

Senator STENNIS. It is contrary to the conception of both tower No. 2 and tower No. 4?

Mr. DELONG. Because tower No. 4 has the same basis, somewhat the same as tower No. 2 when you take it from the ocean floor and take it from this level.

Senator STENNIS. All right. Confronted with the facts as they were, when this additional bracing was put in above the water, what was the sound course to follow there? Was there any repair that could have been made, that you think would have been sound?

METHOD OF REPAIR SUGGESTED

Mr. DELONG. Mr. Chairman, for me to answer the question or make any such statement is something like Monday morning quarterbacking. We do not know enough of the situation. When bracing started to give way and so forth, I think that you knew that you were on, as I would say, a short fuse. You were headed for serious trouble, and the only way that it could be done is actually a replacement of the bracing. Then you would have to start in at the top, build up around the legs, up above the water, start sinking them down, the same thing you have there. But you would have the sleeve over the legs, then go down with burners and cutting torches and cut these out as you keep sinking. Then progressively from the top, you would work down to the bottom and replace your bracing structure that was giving trouble.

After you had it all done, you would grout it in between this leg that is coming down and this leg, and you would have a solid structure.

Senator STENNIS. You would replace the old braces with new ones which you would weld in progressively and one at a time. Is that correct?

Mr. DELONG. You would bring them as a section. You would take a whole section, redesign it and lay it out. You would make a caisson or a sleeve that would fit around, full length, that would fit around this pipe. This pipe is 12½ feet in diameter so that one would probably be a couple of inches larger. You would make it not too large, but you would try to hold it to a couple of inches that while you were going down, you would still get some support from the structure as you were sliding down. Because this structure, as you were building it, sliding it down, would have to take the place of the structure you were cutting out. You would cut the structure out only ahead of the sinking of the top structure. Whatever that was you would want to keep, whether some of it broke or not; you would want to get all the benefits you could from it until you got all the way down.

You would have to remove it ahead of the lowering of the section you are doing. So all you are doing, you are floating this braced structure, surrounded by a bigger tube, that this comes down in. As you go down, you are clearing all this up, take that out.

Then you have from here to here an unsupported column. You could have hard luck and have a storm and get in serious trouble. But that would be the only way that I could see you could have made some effort to salvage it.

Senator SALTONSTALL. Mr. Chairman, that would not be a salvage, would it, Mr. DeLong? It would really be building a complete new tower.

Mr. DELONG. It would be building new bracing, and that would be a method of saving the tower. Because that is only a portion of the work. It would probably involve 1,800 or 2,000 tons of steel. I am just making a guess.

Senator STENNIS. Well, in view of what was testified yesterday and in the light of your testimony today, it seems clear to me that the more practical thing would have been just to abandon the tower when they were confronted with this situation which required putting in the bracing above the water.

All right, proceed now with any points that you have in mind, and then we shall go back to Mr. Bauer.

Mr. DELONG. I think, Mr. Chairman, that I do not have anything more to add to this. The statement was made that this water depth was impossible and so forth. We do not agree with that. We have offered to build structures in 300 feet of water. We have worked barges in 210 feet of water. It is just a matter of working out the problems. That is all I have to say.

Senator SALTONSTALL. Mr. Chairman, may I ask one question?

Senator STENNIS. Certainly, Senator.

Senator SALTONSTALL. Mr. DeLong, did you ever bid on Texas tower No. 4?

Mr. DELONG. Yes, sir, we bid on Texas tower No. 4.

Senator SALTONSTALL. Did you withdraw that bid when you saw what the plan or design was?

Mr. DELONG. We had an agreement to be able to do it under scheme B. That is the scheme that we have described. And under scheme

B, taking the proper precautions and after considering our estimate of cost, we submitted a tender.

Senator SALTONSTALL. I am not informed what scheme B is, but I assume that is what you have just described?

Mr. DELONG. Scheme B is where we floated out the template in upright position, which was all welded, and sank it down on the ocean floor.

Senator SALTONSTALL. I have one other question. Do I understand from your testimony that the fault was not in the design, but in the method of installation and that the resulting damage came from the installation?

AGREEMENT WITH DESIGN

Mr. DELONG. No, the principle of design is not wrong, the K-bracing.

Senator STENNIS. It is right, you say?

Mr. DELONG. The principle of K-bracing using a triangle structure in deep water is practically the only economical way to do it.

Senator SALTONSTALL. So your criticism is in the method of installation rather than in the design?

Mr. DELONG. The method of pinning, the bracing versus welding, and a tipping of the tower, and the exposure of bringing a big platform into the sea and trying to fasten it on the legs and raising it in the air.

Senator SALTONSTALL. So you would only proceed under what you call scheme B, and not under the scheme of installation that was recommended?

Mr. DELONG. That is correct.

Senator SALTONSTALL. May I ask one more question on physics?

Will the strength of the waves in the Atlantic Ocean bring greater pressure on a tower of this kind than the strength of the waves, say, in the Gulf of Mexico?

Mr. DELONG. No, I would say they are somewhat comparable. We have had 55 foot waves in the Gulf of Mexico and a 150 mile an hour hurricane at the same time.

Senator SALTONSTALL. Mr. Chairman, I have no more questions.

Senator STENNIS. Thank you, Senator. The Chair proposes, with the consent of the committee, to let Mr. Bauer finish his statement now. Then we shall have questions, first by members of the committee and then counsel will close on any points that have not been covered.

Mr. Bauer, you may proceed.

Mr. BAUER. Well, I think that it has been pretty well covered. What I had started to do is compare the two methods, and I think that has been pretty well covered.

Senator STENNIS. Well, were there other points that you had in mind that have a bearing on this picture?

Mr. BAUER. No, I do not think so. I think I have completed my statement.

Senator STENNIS. All right, then. We may now address questions to each of these gentlemen. Frankly, between them, they have covered the points that came to my mind during this hearing, and I think their testimony is much clearer than some of the high-powered prepared statements that we sometimes had to wade through.

Yesterday, I was impressed with the testimony of Dr. Charyk and Captain Albers and with the fact that they were being very clear and frank about these matters.

Senator Saltonstall, do you have any questions of these gentlemen?

Senator SALTONSTALL. I do not think, Mr. Chairman, that I have any further questions.

I assume, Mr. DeLong, that you are testifying here now as an expert on this type of structure, and from your experience in Texas tower No. 2, because you did not have personal observation in Texas tower No. 4 after you decided not to go forward with your bid due to the method of installation. Is that correct?

Mr. DELONG. We did bid, Senator, with an alternate scheme of building and erection.

Senator SALTONSTALL. I could not hear that answer.

Mr. DELONG. I said we did bid on Texas tower No. 4, with an alternate scheme of erection and construction.

Senator SALTONSTALL. So that when that alternate scheme was refused, then you would no longer bid on the other scheme?

Mr. DELONG. Sir, the alternate scheme was not refused. We were just not low bidder.

Senator SALTONSTALL. I see. So that your testimony here today is as an expert in answering questions as to this method of building the structure rather than from your own experience on the structure?

Mr. DELONG. We are here in answer to a subpena, and whether we are experts I think would be a little hard for us to judge. We have been living with these problems for 10 years, but they tell me that an expert is a man away from home.

Senator STENNIS. Yes, Senator, you were detained on other matters. The Chair stated in the beginning that Mr. DeLong was here under a subpena of the committee because of his vast experience with and knowledge of this type of construction.

Senator Jackson, have you any questions?

Senator JACKSON. Mr. Chairman, I merely want to associate myself with the chairman. I think the witnesses here this morning have presented this matter with great clarity and understanding.

EXPERIENCE OF DE LONG CORP. IN OFFSHORE PLATFORMS

I might just ask this one question: How many of these towers have you put up at sea, not necessarily radar towers but oil drilling and other types of towers at sea, and how long have you been doing this? When did this idea start, in general?

Mr. DELONG. Since 1949.

Senator JACKSON. How many have you put up, roughly?

Mr. DELONG. Senator, I am just making a guess—50, 55.

Senator JACKSON. I take it you have had some experience.

Mr. DELONG. I can assure you that we have had our problems, and we anticipate that we are going to have some more as time goes along.

Senator JACKSON. How deep has the water been at some of the platforms that you have put in?

Mr. DELONG. We have worked one off the coast of California in 210 feet of water. At the present time, we are designing a structure to lay a tunnel under the English Channel in 186 feet of water, building submerged tunnel sections, and using a DeLong type platform.

Senator JACKSON. And your firm is working on that at the present time?

Mr. DELONG. That is correct.

Senator STENNIS. Mr. DeLong, right at that point, this is a relatively new field, is it not, building towers in such deep waters, is that right?

Mr. DELONG. Well, my only comment on that is the lot of a pioneer is a rugged one.

Senator STENNIS. Mrs. Smith, we shall be glad to hear from you.

Senator SMITH. Thank you, Mr. Chairman; I have no questions.

Senator STENNIS. Senator Bartlett?

Senator BARTLETT. I have no questions, either, Mr. Chairman, thank you.

Senator STENNIS. The Chairman will call on Counsel Kendall here, and Mr. French, who prepared a good deal of this information.

Mr. KENDALL. Getting back to the imbedment question, if these legs were not embedded deeply enough, Mr. DeLong, would that contribute to a swaying of the platform?

Mr. DELONG. That is a little difficult question to answer. If the legs were not embedded deeply enough, they would be moving, and as the waves hit the towers, the leg on that side would come up and then come back down. If that condition arose, why, I think you would have problems very quickly.

Mr. KENDALL. Would that question be affected one way or the other by the presence or absence of driven piling?

Mr. DELONG. The driving of piling and concreting them into the bottom of the tower is to operate as an anchor, and also as a load-bearing member. I feel that the question is in relation to tower No. 4, and from what I understand, the footings were in solid position.

Mr. KENDALL. Would that necessarily indicate that there had not been any scouring or sucking action under those footings?

Mr. DELONG. Well, I think it would be. It would be hard to check whether the footings had moved in the sea, down there 185 feet, and 150 feet or 175 feet from one leg to another, whether they are in a true plane to one another, I think, would be a little hard to check. As I understand from the divers' report the footings appeared undisturbed. So we are assuming that the footings withstood the elements.

Mr. KENDALL. Well, the situation here, Mr. DeLong, is that, during the course of construction, a change was made to eliminate the pilings and to reduce the embedment of the legs from 20 to 18 feet. What is your opinion as to the effect of those changes as contributing to any motion or swaying of the tower?

Mr. DELONG. Mr. Kendall, I do not think that I could express an opinion. I think they were competent foundation people, who analyzed the problem, and I think I would be out of order in trying to second-guess what they did.

Mr. KENDALL. Do you not have an opinion on that question, as a man experienced and well versed in this field?

Mr. DELONG. Well, you take a tower and put it in the ocean, and the height is 250 feet, from the ocean floor to the bottom of the platform, and in sand, and you excavate the footings only 18 or 20 feet, I would say that you would have to be an awful bold man to do it.

Because on the tower No. 2, we went in 48 feet, and it is common knowledge that in the Gulf of Mexico, we get scour around the struc-

tures of 8 to 10 feet. It is also something to worry about that when you put an obstruction down there 25 feet in diameter and the current probably going around it, that it will erode. But I am also quite sure that the design engineer has taken that all into consideration.

That is why I say I would not want to be presumptuous enough to question it. But not knowing anything about it and having the experience of the others, why, it appears that you are on awful shaky assumptions that 18 or 20 feet is enough.

But I can say again that the design engineer probably has taken all that into consideration, and that there was no erosion and that the footings are in place, from those facts, you can assume that he was correct.

Mr. KENDALL. But he would fall into your designation of a bold man, I believe you said.

Mr. DELONG. Well, it is bolder than I would want to be.

Mr. KENDALL. So I take it you would not design the tower to be so constructed?

Mr. DELONG. I do not believe that that is an easy one for me to answer.

Mr. KENDALL. Well, let us go to a slightly different question, Mr. DeLong. From the standpoint of future experience, particularly with reference to towers No. 2 and No. 3, for example, which are still standing, do you think it would be worth the expense to go down and recover samples of the caissons and make footing measurements, and so forth, to determine exactly what happened upon the collapse of the tower?

Mr. DELONG. Well, Mr. Kendall, I do not know how you mean that. Talking purely from the DeLong Corp., it would not mean anything to us.

Mr. KENDALL. Not even in relation to towers No. 2 and No. 3?

Mr. DELONG. No; towers No. 2 and No. 3—No. 3 was built the same as No. 2. I do not think there are any problems. We feel confident there are no problems with tower No. 2, and I think that No. 3 was constructed as the design engineers drew it up, and so forth, and there should be no problems with tower No. 3. Your problems are very simple on tower No. 4; it is accumulation.

Mr. KENDALL. Mr. DeLong, this so-called tip-up method of erection, that is a patented process, is it not? Mr. Kuss holds a patent on that process?

KUSS TIP-UP METHOD OF ERECTION OBJECTIONABLE TO DELONG

Mr. DELONG. So we understand, but I do not think that he made any charge for it or anything like that. But it is the Kuss method.

Mr. KENDALL. Do I understand you to say that if the Kuss method had been insisted upon, you would have refused to bid upon tower No. 4?

Mr. DELONG. That is absolutely correct. If we did not have an understanding that we could use an alternate scheme, we would not have bid.

Mr. KENDALL. With whom did you have that understanding, and at what point in time?

Mr. DELONG. Our chief engineer worked with the design engineers.

Mr. KENDALL. That was Mr. Suderow?

Mr. DeLong. That was Mr. Suderow, yes. And we worked out the methods. It was his job to get the approval. We got the approval verbally, and so stated to our associate, Raymond Concrete Pile. We accepted it and submitted a tender on No. 4.

Mr. Kendall. This was prior to the receipt of bids?

Mr. DeLong. It was prior to the receipt of bids. In fact, our joint venture agreement, and memorandum of agreement of equipment, was written on October 28, 2 or 3 days before the bid.

Mr. Kendall. You say you had a memorandum of agreement?

Mr. DeLong. Yes, between us in the joint venture.

Mr. Kendall. What was the date of that?

Mr. DeLong. October 28.

Mr. Kendall. We would like you to make a copy of that available for the record, if you do not mind. We have a copy you furnished us under subpena.

Mr. DeLong. The memorandum of agreement between the joint venture?

Senator Stennis. Without objection, this will be admitted in the record.

(The documents referred to are as follows:)

This Memorandum of Agreement made and entered into this 28th day of October 1955 by and between Raymond Concrete Pile Company, a New Jersey corporation, hereinafter known as "Raymond", and De Long Corporation, a Delaware corporation, hereinafter known as "DeLong";

Witnesseth:

Whereas Raymond and De Long have heretofore entered into a Joint Venture Agreement under the name "Raymond-De Long" for the erection and construction with the Bureau of Yards & Docks of the United States Government for Texas Towers #1, #3 and #4 and such other Texas Towers as may subsequently be awarded by the United States Government, and,

Whereas said Joint Venture will employ methods and jacking equipment solely owned by De Long Corporation and protected by United States Patent Applications Nos. 143,627, 283,567, 523,323 and other United States and foreign patent applications filed by De Long Corporation, and,

Whereas it is contemplated that the Joint Venture will use De Long jacks in the erection and construction of said Texas Towers, which jacks shall be the sole and separate property of De Long.

Now Therefore, for and in Consideration of the premises and the mutual agreement of the parties hereto it is agreed by and between Raymond and De Long as follows:

I

De Long shall furnish to Raymond-De Long, a Joint Venture, the use of twenty-two (22) De Long Air Jacks, presently employed on Texas Tower #2 being Contract NOy-88201, for a rental price of five hundred dollars ($500.00) per month per jack provided that said rental charge shall not exceed the sum of forty-nine thousand five hundred dollars ($49,500.00) per tower or a total rental charge of one hundred forty-eight thousand five hundred dollars ($148,500.00) for Texas Towers #1, #3 and #4. Raymond-De Long shall store, repair and maintain said Air Jacks and keep in good operating condition the same as when received, less reasonable wear and tear while in their possession. Upon removal from the Towers and completion of the usage under Texas Towers #1, #3 and #4, the Air Jacks shall be returned to Orange, Texas by the Joint Venture.

II

De Long shall manufacture and furnish to Raymond-De Long twelve (12) De Long Pin Jacks employing the hydraulic principle embodied in United States Patent Application Serial No. 523,323. A lump sum rental charge of eighty-six thousand four hundred dollars ($86,400.00) shall be charged against the Joint Venture by De Long for the use of said Pin Jacks on Texas Towers #1, #3 and #4. Title to said Pin Jacks shall be and remain the sole and separate

property of DE LONG. The storage, repair, maintenance and shipment of the Jacks, together with installation cost on the Towers shall be for the account of the Joint Venture. Upon completion of Texas Towers #1, #3 and #4 said Pin Jacks shall be returned to Orange, Texas by the Joint Venture.

III

It is contemplated that RAYMOND-DE LONG shall manufacture or cause to be manufactured for use on Texas Towers #1, #3 and #4 a dual purpose supply barge or a single purpose supply barge employing the specialized principle of the DE LONG Air Jacks. Said barge shall be manufactured by RAYMOND-DE LONG and considered as Joint Venture property. It is estimated that the total cost of the dual purpose supply barge shall not exceed three hundred thirty-three thousand and 00/100 dollars ($333,000.00) and the total cost of the single purpose supply barge shall not exceed one hundred eighty-two thousand and 00/100 dollars ($182,000.00). A minimum write-off of seventy-five per cent (75%) of the total cost of the dual purpose supply barge or fifty per cent (50%) of the single purpose supply barge shall be written off by the Joint Venture against Texas Towers #1, #3 and #4. Upon completion of said contract and if it appears that there is no further use for the barge by the parties acting together, DE LONG agrees to purchase the barge at its depreciated book value provided that it cannot be sold to any bidder at a higher price.

For the use of all jacks provided herein, DE LONG shall charge RAYMOND-DE LONG a royalty charge of one percent (1%) based on the total contract price including extras of Texas Towers #1, 3, and 4 or such other Texas Towers contract as may be subsequently entered into by the Joint Venture with the United States Government, provided that said royalty charge shall not exceed the fixed sum of one hundred thousand dollars ($100,000.00) per Tower on Texas Towers #1, 3, and 4. It is understood and agreed that the one percent (1%) royalty charge above mentioned and the jack rental provided for under Article I shall not be due and payable by the Joint Venture to DE LONG on Texas Towers #1, 3, and 4 until the net profits of the Joint Venture, excluding royalty or jack rental charges under Article I, exceed twelve and one-half percent (12½%). Said payments shall be due and payable only from the net profits of the Joint Venture as defined herein in excess of twelve and one-half percent (12½%). The term "net profits" shall be defined to include the total contract price including extras less all costs similar to Item I to VIII and other field cost specified on Exhibit E, page I of the RAYMOND-DE LONG proposal submitted to the Bureau of Yards and Docks on Texas Towers #2, Contract NOy-88201. In computing "net profits" for the purpose of this Article only, no deduction shall be made for General and Administrative Expense (main office overhead of both RAYMOND and DE LONG or the royalty or jack rental costs due DE LONG under Article I. On Texas Towers #1, 3, and 4 the royalty and jack rental charge shall be paid from all net profits over and above twelve and one-half percent (12½%) until the total royalty and jack rental charge provided for herein has been paid.

IN WITNESS WHEREOF, the parties hereto have set their hands and seals this 28th day of October, 1955.

RAYMOND CONCRETE PILE COMPANY,
By G. F. FERRIS.

Attest:

H. O. FEDERA,
Secretary.

DE LONG CORPORATION,
L. B. DE LONG.

Attest:

EDWARD A. FAY,
Secretary.

THIS JOINT VENTURE AGREEMENT entered into this 28th day of October 1955, by and between RAYMOND CONCRETE PILE COMPANY, a New Jersey corporation (hereinafter referred to as "Raymond") and DELONG CORPORATION, a Delaware corporation (hereinafter referred to as "DeLong"),

WITNESSETH:

WHEREAS the parties in a Joint Venture were awarded Contract NOy–88201, for the construction of an air raid warning platform designated as the "Texas Towers" platform located on George's Bank, and have substantially completed said contract, and

WHEREAS the Navy has requested proposals for three additional Texas Towers to be erected, and

WHEREAS it is the desire of both parties to enter into a new Joint Venture for the bidding and, if awarded a contract, the furnishing and erection of said Texas Towers, or any of them on which they may be successful bidders,

NOW THEREFORE, for and in consideration of the premises and the mutual obligations of each to the other, it is agreed as follows:

1. Raymond and DeLong hereby associate themselves into and as a Joint Venture for the purpose of preparing and submitting to the Bureau of Yards and Docks of the United States Navy, a proposal to furnish, erect, and install three (3) air control and warning towers, referred to as TT–1, TT–3 and TT–4, or any of them, and other work that may be included in such a program and if awarded a contract for such work, to jointly perform said contract by furnishing, erecting and installing said control towers, or any of them, in accordance with the contract so awarded. The contract and the work thereunder is hereafter referred to as the "Project".

2. The interests of Raymond and DeLong in and to the Joint Venture and in and to all property, materials and equipment acquired in connection therewith shall be in proportion of fifty per cent (50%) to Raymond and fifty per cent (50%) to DeLong.

3. All net profits of whatsoever kind and character received from the performance of the Joint Venture and any and all losses resulting therefrom shall be participated in and shared equally by the parties hereto in the proportion of fifty per cent (50%) each.

4. All obligations and liabilities of any kind or character which are assumed or undertaken by the parties hereto or either of them in connection with or for the benefit of the Joint Venture shall be shared in the proportion of fifty per cent (50%) each by the parties hereto, but no obligation or liability of any kind shall be incurred for or charged to the Joint Venture by either party without the express consent of the other party.

Included as costs against the Joint Venture shall be the charges agreed to in the memorandum agreement signed by the parties this 28th day of October, 1955 with regard to patent royalties and rental for air jacks and pin jacks and rentals for supply barges.

5. All necessary working capital when and as required for the performance and prosecution of the Joint Venture and the Project shall be furnished by the parties hereto equally.

6. All funds advanced by Raymond or DeLong and all funds received for the performance of the contract and the Project shall be deposited in such bank or banks as the parties hereto may agree upon from time to time and be held for their joint account, subject to withdrawal by such person or persons as the parties hereto may from time to time designate.

7. The parties hereto shall both make available for this work the technical advice and benefits of their individual experiences and shall in all other respects endeavor to share the responsibility and burden of the performance of the work. To that end, each of the parties shall furnish to the Project such of its personnel and equipment as may be required for the performance of the Project, and as either of the parties may be able to spare without detriment to its other business. Raymond shall make available the administrative and accounting personnel.

8. Neither Raymond nor DeLong shall make any charge against the Joint Venture for the time which may be expended in connection with the performance of the Project or for any services rendered on behalf of the Project (other than for mutually approved actual out-of-pocket expenses and for plant rental as hereinafter provided) nor shall either Raymond or DeLong be entitled to compensation or reimbursement for any part of the salaries of their executives or other officers or employees, or for any part of their general overhead expenses except where such executive officer or employee is assigned to the Project by mutual agreement.

9. No charge shall be made for rental of equipment furnished to the Project except upon terms to be mutually agreed upon.

10. A complete set of books and accounts correctly and adequately reflecting the business transactions of the Joint Venture shall be kept in accordance with good accounting practices which shall be open to the inspection of either party at any reasonable time.

11. Upon the termination of this Project, the parties hereto shall liquidate the assets of the Joint Venture and shall render a true and correct accounting,

each to the other, of all expenses incurred on account of the performance of the Project and of all moneys or other property received as a result thereof, and the parties mutually agree upon the termination of the Project and the Joint Venture to settle and adjust all accounts in connection therewith and to pay each to the other such sums as will result in each of the participants receiving fifty percent (50%) of the profits or bearing fifty percent (50%) of the losses arising therefrom.

12. It is specifically understood and agreed between the parties hereto that this Joint Venture Agreement extends only to the performance of the Project together with any changes or additions thereto or extra work thereunder. In no event shall this Agreement extend to or cover any other or different work.

13. Neither Raymond nor DeLong shall sell, assign or in any manner transfer its interest or any part thereof in this Joint Venture without first obtaining the written consent of the other Joint Venturer; and any attempted assignment without such consent shall be void.

14. In the event that a receiver, trustee in bankruptcy or other custodian of the property or franchises of either of the parties shall be appointed or if either of the parties shall be declared a bankrupt or insolvent or be dissolved, then and in any such case the other party shall have the right at its option to exclude the insolvent party, its successors, receivers or legal representatives from further participation in the management of the Joint Venture and may take over the interest of that party in the Joint Venture (but without prejudice to the obligation of that party or its representative to bear his proportionate share of the loss resulting or to result from the Joint Venture) and shall in addition have the right at its option to wind up the affairs of the Joint Venture and in that connection to carry on and complete the performance of the contract. Upon completion or sooner termination of the contract and receipt of payments therefor under the contract, the party not insolvent shall account to the insolvent party or its representatives and such party shall be entitled to receive an amount equal to the sums advanced by such party plus such party's proportionate share of any profits earned and received to the date when such party was excluded from the Joint Venture or less such party's proportionate share of the losses resulting from the performance of the contract whether before or after the date when such party was excluded from the Joint Venture. In the event that the share of the losses chargeable to the party so affected exceeds the sums advanced by such party toward the working funds of the Joint Venture, such party or its representative shall promptly pay the excess to the remaining party. The books of the Joint Venture shall be conclusive in establishing whether a profit has been realized or a loss sustained and the amount thereof.

15. The obligations herein assumed by each party are solely for the benefit of the other party of this Agreement and are not intended to, and shall not, enure to the benefit of any other person, firm or corporation.

16. This Agreement is entered into in the City of New York, State of New York, and shall be governed in all respects by New York law.

17. All disputes arising in connection with this Agreement or the breach or claimed breach hereof shall be finally settled under the rules of the American Arbitration Association of New York State.

IN WITNESS WHEREOF, the parties hereto have executed this Agreement under their seals the day and year first above written.

Attest:

RAYMOND CONCRETE PILE COMPANY,
By G. F. FERRIS.
H. O. FEDERA, *Secretary.*

Attest:

DELONG CORPORATION,
By L. B. DE LONG
EDWARD A. FAX, *Secretary.*

Mr. KENDALL. In other words, Mr. DeLong, I understand that you were not actually bidding tower No. 4 as it appeared in the designs and specifications, is that correct?

Mr. DELONG. That is correct.

Mr. KENDALL. And you would have not constructed it in that manner even if you had bid low?

Mr. DELONG. On our setup, I do not think we could have done it.

Mr. KENDALL. Was your understanding with any person other than someone in the Moran, Proctor firm? The contracting officer, for example, would not you have to have that understanding with him?

Mr. DELONG. Well, I listened to the contracting officer's statements yesterday, and I do not feel I want to take exception to him. He said he did not have any understanding. I did not talk to the contracting officer myself about it. It was handled by Mr. Suderow, and I accepted the contract officer's statement that Mr. Suderow did not have an understanding with him but had an understanding with the design engineers. You want to remember, we were consulted on the first one and helped work out the problems on Texas tower No. 2, such as taking out the bracing and the method of erection, and so forth.

So the relationship was friendly, cooperative, and we felt no hesitation, after the method was discussed with the design engineers, and if you will look in your copy of the Design and Construction Report, at figure 48, as constructed, you will see part of the method in there for scheme B. But I will say that Captain Albers, no doubt, is correct when he says that he did not have a definite understanding.

Mr. KENDALL. Do you have any other documentation of the fact that you did not bid and did not propose to construct tower No. 4 if successful as it was designed? Did you have any plans or drawings?

Mr. DELONG. We have drawings that we submitted to you, on the method of installation. The date of them is October 26 or something like that, our last erection drawings. We had another method that we prefer, which we would use in deeper water, but our chief engineer was unable to get approval on that method, so we went to the method that we put our tender in on, on scheme B.

Mr. KENDALL. Would you explain briefly what those drawings are, and make them a part of the record, sir, and give the dates again?

(The drawings referred to are shown facing this page.)

Mr. DELONG. We have a drawing here dated September 30, 1955, which is the method that the DeLong Corp. would employ today putting structures into 200 or 300 feet of water. But our chief engineer reported to us that there were certain objections; the design engineers were not happy about it. They thought they did not want to go along, so we worked out the alternate scheme of taking part of their tower the way they had lined it out, and do it in a method that we could live with and feel that we would be successful in it, and have it under control. After all, it is dated the 17th day of October 1955.

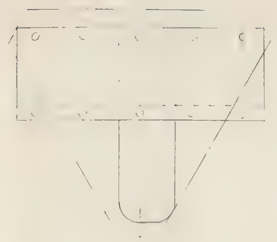
This drawing is the basis for the agreement between the joint venturers, Raymond Concrete Pile at that time, now the Raymond International, who were our co-venturers on tower No. 2, as to how we would do it, as to what equipment, what special jacks to raise the structures, and so forth, how it would be written off, special barges, and things like that.

Mr. KENDALL. Were these drawings or plans submitted to the design engineer and the Navy?

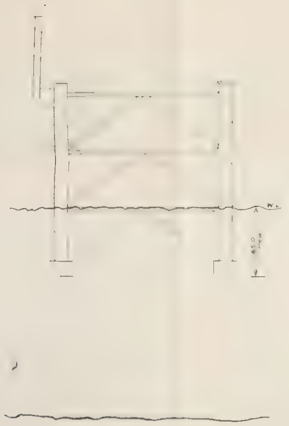
Mr. DELONG. Well, the drawing dated October 17 is in the book as figure 48.

Mr. KENDALL. That is the design and construction report that you refer to?

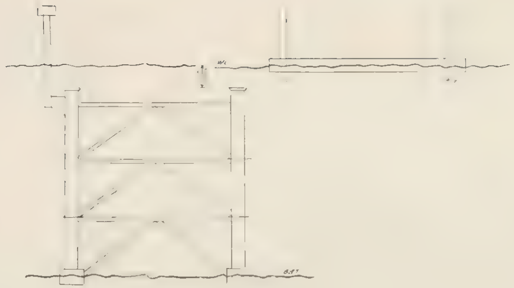
Mr. DELONG. Yes, sir.



PLAN VIEW
TEMPORARY PLATFORM

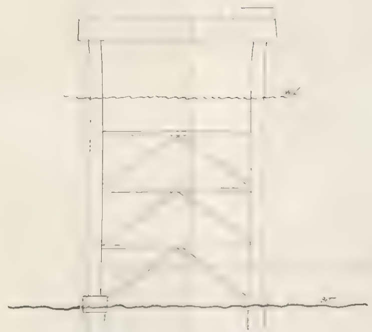


TEMPLAT FLOATING OU[illegible]
CONTROL TOWERS

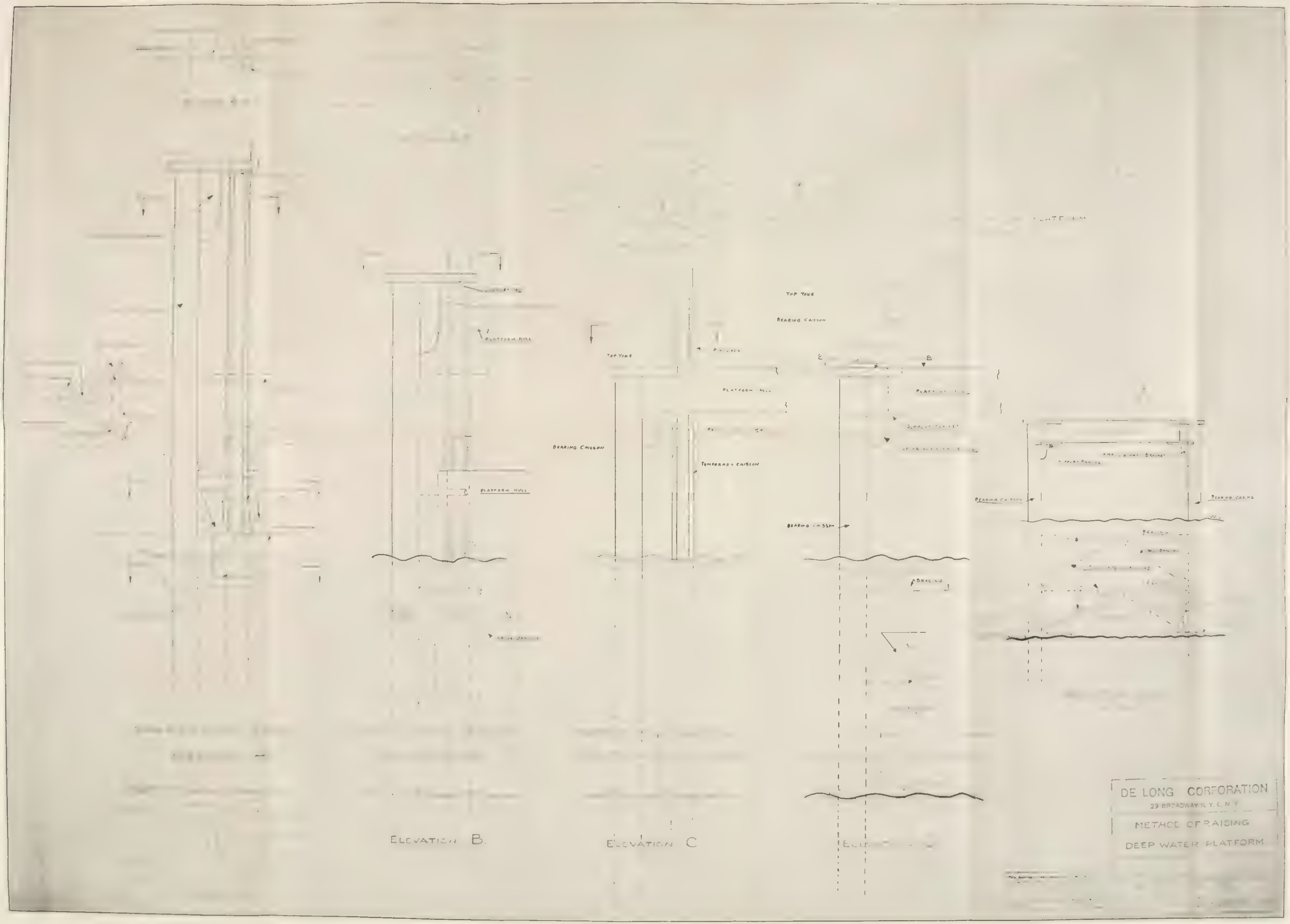


[illegible] DOWN TO BOTTOM & LEVELLED
WITH TEMPORARY PLATFORM APPROACHING

TEMPORARY PLATFORM FLOATED OVER
TEMPLATE, JACKED UP & PILING DRIVEN



TEMPORARY PLATFORM REMOVED PERMANENT
PLATFORM FLOATED OVER TEMPLATE WITH
DECKHOUSE COMPLETE & JACKED UP &
WELDED OFF



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Mr. KENDALL. Well, I take it, then, your answer is what? I am talking about prior to the bidding on November 1. Were they submitted to the design engineer and the Navy, or either one of them?

Mr. DELONG. Mr. Kendall, they would not have been submitted after the tender.

Mr. KENDALL. Let us see if we cannot answer this responsively, Mr. DeLong. I take it your answer is either yes or no. Now let us get the yes or no.

Mr. DELONG. The reason my answer is the way it is is because it was handled by our chief engineer, and I personally did not handle it or have the agreement or present the papers.

Mr. KENDALL. You received a report from your engineer, did you not?

Mr. DELONG. That is correct; that it was approved and it was agreed on.

Mr. KENDALL. Approved by whom?

Mr. DELONG. I have to go back and try to talk to some other people and so forth, but I know one was Mr. Rutledge, the design engineer. Whether it was with Captain Albers—evidently not, because Captain Albers said that he had no prior agreement. But the design engineers submitted it in their design criteria, method of construction, and so forth. So I think it was between the design engineer and ourselves, and that there was no question in my chief engineer's mind or the design engineer's mind that the contracting officer would not approve it.

Mr. KENDALL. In reviewing the bids that were received you were low on everything but Texas tower No. 4, or any combination where Texas tower No. 4 was involved?

Mr. DELONG. I believe that is correct.

Mr. KENDALL. Well, can you explain why you should be low on towers No. 1 and No. 3, and more than a million dollars higher on tower No. 4? Is there any reason for that that you can give us?

Mr. DELONG. Well, I think it is probably an evaluation of the problems that made a difference. We made an estimate, evaluated all the problems, the special equipment that we would have to use and so forth, and put it in our estimate, a fair bid and we were not successful.

In the comparison of bids, tower No. 4 and tower No. 3 on the face of it, makes you think it was lack of knowledge because the figures are very close together, one tower with another, and one tower is in 80 feet and one tower is in 185 feet.

DEPTH OF WATER IS IMPORTANT COST FACTOR IN BIDDING

Mr. KENDALL. In other words, the greater depth of the water contributed to a substantially increased cost; is that what you mean?

Mr. DELONG. Always does.

Mr. KENDALL. Mr. DeLong, to get back to the erection process for a moment, would you say that the loss of those diagonals during tow was a serious structural mishap?

Mr. DELONG. Will you repeat the question, please?

Mr. KENDALL. Would you say the loss of those diagonals during the tow or erection was a serious structural mishap or defect?

Mr. DELONG. This, I would say, was quite a disaster.

Mr. KENDALL. The chairman asked this question, Mr. DeLong: Is it not a fact that if that had happened to you, you would have taken that tower back to port for repairs?

Mr. DELONG. That question I think I answered to the chairman.

Mr. KENDALL. I think you declined to answer it, and I think you have a very definite opinion on it right now.

Mr. DELONG. I would not know. I do not know what my decision would be; yes, sir. To be perfectly frank, we would probably have a meeting to see what could be done and so forth. To say that I would definitely go back to the harbor, I would be making a statement that I do not know the answer to.

Senator SALTONSTALL. I value your testimony more when you give that answer than if you had given an answer yes or no.

Mr. DELONG. Well, Senator, you really do not know.

Senator SALTONSTALL. I said I respect all your testimony because you did not answer it.

Mr. DELONG. Thank you.

Senator STENNIS. Proceed, Mr. Kendall.

Mr. KENDALL. May I have just a moment?

Senator STENNIS. Certainly.

Mr. KENDALL. Mr. DeLong, I do not want to belabor this matter, and certainly I do not want to embarrass you. The point was made in my original question, and I can understand that you do not care to say bluntly what you would have done, because you did not face those facts. However, on your other testimony and your knowledge and experience, I very definitely get the impression that you would certainly have leaned toward taking the tower back for repair or rebuilding. Is that correct?

Mr. DELONG. Mr. Chairman, you see the problem that would face you at that time. If you went back, you would open what we have referred to as a Pandora's box. You would say, "Well, I had this problem once, will I have it again?" So your natural reaction would be to try to tough it out, stay there and try to repair it and do something with it. If I were committed to this course, that would be my reaction. If I were in this position, I would make every effort to stay there.

Senator STENNIS. That is the next point. As you have expressed it, having been committed to that course—you mean by that the method of erection, I assume?

Mr. DELONG. Yes, sir.

Senator STENNIS. In other words, if I understand you correctly, if you had gone back for repairs and had continued to follow that method of erection, you could have been confronted with the same problem again?

Mr. DELONG. That is correct, sir. You might be. You might at that time leave the diagonals off instead of trying to lash them, which is—that decision to lash them is not an unreasonable one, because to take them off, you would have to make another pin connection down there.

Senator STENNIS. If they had taken them off before they upended the tower, they would still have had the problem of putting them on under water; is that what you mean?

Mr. DELONG. They still have the problem of putting the top pin in. That is the pin in here [indicating]. But they evidently made

the decision, and I would not say we would not make the same decision. But if we had made it, we would have had the problem of saying, "Boys, we wish we had taken it off, because we had the other connection to make." Since you had to make the connection anyway, it would be one more.

Senator STENNIS. By that line of reasoning, this problem goes back to the method selected in getting the tower in place?

Mr. DELONG. Well, Mr. Chairman, we just disagreed with the method.

KUSS METHOD OF ERECTING CREATED PROBLEMS

Senator STENNIS. Well, it is a fair statement, is it not, to say that this trouble actually goes back to the method selected in putting this tower into position?

That is the way it looks to me, as a layman, based on the testimony that I have heard here. As I understand your concept of this thing, that was the wrong method by which to erect it, and the facts have certainly proved that something was seriously wrong.

Mr. DELONG. Mr. Chairman, under our method we would not have faced these problems.

Senator STENNIS. I know you would not.

Mr. DELONG. That was our objection to it to start with. We were visualizing and foreseeing problems that could arise like this, and worse.

Senator STENNIS. That is correct.

Well, I think that is clear. You have made that clear. I shall not press that point any more. It seems obvious to me.

Senator Jackson, do you have anything further?

Senator JACKSON. No further questions.

Senator STENNIS. Senator Bartlett?

Senator BARTLETT. No, sir.

Senator STENNIS. Mr. Kendall?

Mr. KENDALL. Mr. DeLong, had this Kuss tipup method ever been used before this time?

Mr. DELONG. Not to my knowledge.

Mr. KENDALL. Has it ever been used since this time?

Mr. DELONG. I would not know.

Mr. KENDALL. As far as you know, has it ever been used since that time?

Mr. DELONG. I would not know.

Mr. KENDALL. I would like you to comment, if you will, on the statement that Captain Albers made yesterday when he said the system DeLong submitted was not suitable for use on tower No. 4.

Mr. DELONG. On Texas tower No. 4?

Mr. KENDALL. Yes, sir.

Mr. DELONG. Well, I think the only one we are talking about is the scheme B, the scheme that he no doubt heard about, and probably in his opinion, it was not suitable for tower No. 4.

Mr. KENDALL. In your opinion, was your scheme entirely workable and suitable?

Mr. DELONG. We had taken their design, taken the risks, as we saw it in our opinion, out of it, made it a welded structure, and said we would put it in, that the end tower would be as they called for in the plans.

Mr. KENDALL. That is all that I have.

Senator STENNIS. While these gentlemen are conferring here, we are nearing the end of your testimony, and of Mr. Bauer's testimony.

For the committee, I certainly want to thank you for coming here. Your testimony has been very revealing and very frank, apparently, and it has been helpful to the committee. As I said in the beginning, we are not looking for someone to punish or to blame. The question involved is the strength of our defenses, the avoidance of these mishaps in the future, and the proper expenditure of the appropriated dollar.

We thank you very much and commend you, too, for what I consider to be very frank, honest and fearless effort to throw light on this situation.

Do you have another question?

Mr. KENDALL. One question, yes, sir.

Senator STENNIS. All right.

Mr. KENDALL. Mr. DeLong, I direct your attention to the model there, to the red diagonal strands, that represent proposed cable bracing to replace two panels of K bracing. Do you have any judgment as to the adequacy or suitability of that?

CABLE BRACING INADEQUATE

Mr. DELONG. I have an opinion on it.

Mr. KENDALL. Would you express it, please, sir.

Mr. DELONG. It would not do any good.

Mr. KENDALL. You mean the cable bracing would not do any good, or that your opinion would not do any good?

Mr. DELONG. The cable stretches. As it gets stressed and so forth, it stretches. It might save the day for another week or month or 2 months, or something like that.

Senator STENNIS. But it would eventually stretch and be of no use, is that right?

Mr. DELONG. Absolutely.

Senator STENNIS. All right. Anything else?

Mr. KENDALL. No, sir.

Senator STENNIS. All right, thank you again, gentlemen, for the committee. We appreciate very much your appearance here.

The committee proposes to proceed, if you have other witnesses.

Mr. KENDALL. We have nothing further for today, sir.

Senator STENNIS. All right, sir. Again thank you and all the others who attended yesterday as witnesses. This is not a law suit, but if there is any further point that the Navy wants to make with reference to this matter, they certainly will have an opportunity to do so.

If there is no further business to come before the subcommittee, we shall take a recess subject to the call of the Chair.

(Whereupon, at 12:15 p.m. the committee recessed subject to the call of the Chair.)

INQUIRY INTO THE COLLAPSE OF TEXAS TOWER NO. 4

WEDNESDAY, MAY 10, 1961

U.S. SENATE,
PREPAREDNESS INVESTIGATING SUBCOMMITTEE
OF THE COMMITTEE ON ARMED SERVICES,
Washington, D.C.

The subcommittee (composed of Senators Stennis (chairman), Symington, Bartlett, Jackson, Bridges, Saltonstall, and Smith) met, pursuant to recess, at 10:10 a.m., in room 235, Old Senate Office Building, Senator John Stennis presiding.

Present: Senators Stennis, Bartlett, and Saltonstall.

Staff members, Preparedness Investigating subcommittee: James T. Kendall, chief counsel; Stuart P. French, professional staff member.

Senator STENNIS. All right, the subcommittee will come to order.

We are very glad indeed to have all our guests, and we want always to have open hearings when we can. But we do want the cooperation of everyone with reference to having reasonable quiet so that everyone can hear and attention can be given.

The committee has a rule that all witnesses who testify before it are sworn, so I am going to ask all those who are going to testify, so far as is now known, to stand and be sworn. We want the reporter to be able to report all your names.

Do you, and each of you solemnly swear that your testimony in all of these proceedings will be the truth, the whole truth, and nothing but the truth, so help you God?

Captain WHITE. I do.

Commander FOSTER. I do.

Mr. CROCKETT. I do.

Senator STENNIS. Turn your names in, now, to the reporter, please, and I shall read a brief opening statement.

The Preparedness Investigating Subcommittee today resumes its inquiry into the reasons why Texas Tower No. 4 collapsed. This offshore platform, designed as an extension of our early warning radar system, fell into the Atlantic in January of this year. Twenty-eight lives were lost.

We have heard the testimony of the Air Force, which had charge of operating the tower; the Navy's Bureau of Yards and Docks, which constructed it; and the architectural firms which have participated in the Texas tower programs.

All, more or less, have added credence to the facts uncovered by the subcommittee which tend to show that the tower's nickname "Old Shaky," should have given rise to its abandonment long before it fell into the ocean.

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Evidence heard during the first 2 days of hearing has pointed to the method of putting the tower in position as the beginning of the end.

Also, evidence has been offered which has led the subcommittee to question the structural integrity of the tower at the time it went into operation because of damage sustained when it was placed on its permanent site some 80 miles from shore.

Several additional questions have been raised thus far. One deals with the underwater repairs which may have permitted some motion in the tower's bracing system and which, in turn, may have caused a gradual deterioration of the tower.

Another question deals with the pin connections used in construction. A pioneer in the design and construction of offshore, open sea platforms told the subcommittee that, in his judgment, pin connections should not have been used in the design.

We are not questioning the concept of a three-legged braced structure. This theory has been proved both feasible and practical—as evidenced in the design and construction of Texas towers No. 2 and No. 3, which are still standing and upon which great reliance has been placed by the Air Force, the operating agency.

The subcommittee hopes the witnesses to be heard today and in subsequent open hearing will place in the record additional pertinent facts that will help the subcommittee determine all of the circumstances surrounding the design, construction, and repair of Texas tower No. 4, which may have led to its collapse.

Today, we expect to hear the following witnesses:

(1) Comdr. Edmund R. Foster, of the Civil Engineer Corps, U.S. Navy, who was the resident officer in charge of construction from January 1957 until November of that same year when the tower was turned over to the Air Force, and remained in that assignment until August 1959.

(2) Capt. Thomas J. White, who has been district public works officer, 1st Naval District, since January 1960.

(3) Alan Crockett, of Marine Contractors, Inc., who made two or three underwater inspections or surveys of the tower while it was still standing in order to check its structural stability. After the tower fell he went underwater and made examinations to determine the cause.

The Chair wishes to reiterate that it is the position of the subcommittee that we will not intentionally go into the question of command responsibility which is involved in the proceeding that has been brought by the Air Force against some of its officers. In attempting to prevent that, we have agreed upon a cutoff date of January 12, this year. This will be adhered to as closely as possible. On that date, which was 3 days before the unfortunate collapse of the tower, a conference was held, the facts were considered, and there were certain exchanges of thought.

The proceedings and charges against the officers and their defense are altogether matters for the Air Force in accordance with established procedures.

We want to protect the Air Force and protect the rights of these men. We do not want to prejudice or interfere with the Air Force proceedings in any manner. We shall keep that in mind and want to

keep the public advised of our position. I make that statement again so that all concerned will know.

I appreciate the presence of all you gentlemen and the cooperation that has been shown by the Navy and by the Air Force.

TESTIMONY OF COMDR. EDMUND R. FOSTER, CIVIL ENGINEER CORPS, U.S. NAVY, ACCOMPANIED BY REAR ADM. W. C. G. CHURCH (CEC), U.S. NAVY, ASSISTANT CHIEF FOR CONSTRUCTION, BUREAU OF YARDS AND DOCKS; GORDON EDWARDS, CONSTRUCTION MANAGEMENT ENGINEER, BUREAU OF YARDS AND DOCKS; JAMES AYERS, UNDERWATER CONSULTANT; AND CAPT. WILL J. DAVIS, U.S. NAVY, LEGAL OFFICER, BUREAU OF YARDS AND DOCKS

Senator STENNIS. Commander Foster, I understand that you flew in here from Guam?

Commander FOSTER. Yes, sir.

Senator STENNIS. We appreciate very much the fact that you are here. I understand that you have a prepared statement; am I correct?

Commander FOSTER. Yes, I do, Senator.

Senator STENNIS. Do you wish to read that statement, or put it in the record and summarize it? We shall do whatever is your pleasure.

Commander FOSTER. I would prefer to read it, Mr. Chairman, if that is agreeable.

Senator STENNIS. Very well. Proceed in your own way, Commander.

Commander FOSTER. Mr. Chairman, members of the committee, I am Edmund Foster, commander, U.S. Naval Civil Engineer Corps. I have been a civil engineer since graduation from Pennsylvania State College in 1935, where I majored in structural engineering. I have 18 years' experience in the Civil Engineer Corps of the Navy, much of which has been spent in the field of construction. Prior to joining the Navy, I was for 7 years an engineer with the Tennessee Valley Authority, progressing from engineering draftsman to the design and construction of heavy structures as a structural engineer.

Senator STENNIS. Commander, excuse me.

Senator Saltonstall, this is Commander Foster, who has flown in from Guam to be our witness today.

Senator SALTONSTALL. Thank you, Senator.

Commander FOSTER. I am presently on duty at Guam in the office of the officer in charge of Navy construction in the Guam area. I reported to my present duty station September 20, 1959, from the district public works office at the 1st Naval District at Boston, Mass. At Boston I was the assistant officer in charge of construction and as such was the officer immediately responsible for the construction of Texas tower No. 4, and the work later required to correct the deficiencies that developed in the summer and fall of 1958.

When I arrived at Boston to relieve Capt. John Albers, the design phases of the tower had been completed, the contracts for construction had been let to J. Rich Steers/Morrison-Knudsen, and the construction of the tower was underway, in that the assembly of the plat-

form was pretty well along and work on the legs was in its initial phases.

By and large, in the discharge of my responsibility, I adhered to the original plans and specifications under which the contract had been let. There were, however, two changes and one installation injury repair which I approved and which I believe are pertinent to these hearings.

DEVIATION FROM DESIGN IN PERMITTING INCREASED TOLERANCES IN PIN CONNECTIONS

Shortly after I took over, and before moving to the site, the contractor requested increase in tolerance between the diameters of the holes and the pins which comprised the connections to the bracing and to the legs. Specifically he requested an increase from one sixty-fourth of an inch to one-sixteenth of an inch for all pins except those which required placement under water. For the latter the contractor requested a difference in diameter of one-eighth of an inch between the pin and the hole. This request of the contractor grew out of difficulties encountered in the insertion of pins through holes in some of the pin plates because some of the pin plates which were welded either to the braces or the legs became slightly out of line in fabrication. The one-eighth-inch tolerance requested for some of the other plates relates to the fact that they were to be inserted at the site and therefore under water which, at best, makes for difficult insertion. This request of the contractor was ultimately approved by me after consultation with the design engineers.

REDESIGN FOR COLLAR CONNECTION TO REPLACE BROKEN BRACES

The second and last change which took place at the site involved the correction of the bracing casualty which was suffered after arrival at the site area during a 1-day storm, followed by 1 day of rough weather immediately prior to upending. The braces in question were the two K braces in the AB plane which were to connect the lateral brace at the 25-foot level to the legs at the 76-foot level.

Senator SALTONSTALL. Mr. Chairman, could the commander point those out by referring to the model?

Senator STENNIS. Yes, if you will, Commander.

Commander FOSTER. That is these two braces right here [indicating], sir.

Senator SALTONSTALL. In blue?

Commander FOSTER. These two blue braces in the top panel here, Senator Saltonstall.

Senator SALTONSTALL. That is on which side?

Commander FOSTER. This is the AB side.

These two braces were tied together by metal couplings for and during the tow in order to permit the platform to be floated into jacking position after the legs were on the bottom. One brace came off sometime during the storm. The other came loose and came off during the course of towing the tower to its exact position. During the storm and rough weather we were anchored. I went out to the site 2 days before the legs arrived to set and mark the erection site. I transferred to the platform in the late afternoon of its arrival and was in

immediate touch with events thereafter. I transferred from the platform to the legs for the final tow to the exact site and the upending process.

Immediately after the brace casualty, I was careful to listen, rather than talk about it with the contractor's people. I should like to emphasize that at that point the tower still belonged to the contractor and the decision as to what to do next was his and not the Government's, through me as the Government's representative. I was not, nor is any military engineer on a contract project, the boss or job superintendent. I was there more in the role of inspector, having after the fact authority to accept or reject work as it progressed. Consequently, I bided my time because I knew that the district public works officer and a representative of the architect and engineer were en route and expected shortly. Such discussion as I did have immediately, was, for the most part, confined to discussions of leg damage, if any, between myself and my assistant, Ensign Poulos.

It should be borne in mind that the missing braces were not at that time vital to the immediate phase—the upending of the legs. Also, until the legs were sunk in the ocean, they could always be refloated and returned to port, if required. I therefore took no action to delay or stop the upending phase of the work.

ATTEMPTING REPAIRS AT SEA DEEMED FEASIBLE

The representative of the architect and engineer, Dr. Rutledge, and the contractor, Mr. Steers, arrived the night of the upending and initial placement operation. Discussions commenced forthwith. Mr. Steers was positive that the braces could be replaced at the site because of the fact that no damage had been done to the legs. Dr. Rutledge and I agreed that site repair was feasible and possible and that a satisfactory solution could be devised.

Sometime later—a matter of perhaps 2 or 3 weeks, and after clearance by the district public works officer—Moran, Proctor, Mueser, & Rutledge assisted the contractor in designing the massive collar brace that was ultimately utilized. The design and method of installation was submitted to me for approval. I discussed the solution in detail with Mr. Kuss, who was throughout the project my contact with the architect and engineer on structural matters.

Thereafter, I approved the collar brace solution, and it was installed by means of both Dardelet and collar bolts as well as concrete bracing of the legs on the inside.

After the legs and braces were in position and during the platform installation, injury in the form of perceptible denting or dishing occurred to the "A" and "B" legs caused by the rubbing action of the platform against the legs due to sea swells.

I would like to interject here, sir, that there was some dishing of the "C" leg, as well.

Senator SALTONSTALL. Mr. Chairman, would the commander explain what the word "Dardelet" means?

Commander FOSTER. Senator Saltonstall, it is a patented bolt which, instead of a smooth shank, has a serrated shank.

May I examine it?

This is a Dardelet bolt. Of course, they come in different sizes, lengths, et cetera.

Mr. KENDALL. Will you explain on the record what that is, Commander?

Commander FOSTER. This is a bolt similar in appearance to an ordinary buttonhead bolt, except for the fact that the shank is serrated, rather than smooth bored.

Senator STENNIS. Why?

Commander FOSTER. These serrations are to hold the bolt tightly in the hole which is prepared for it, and are always installed with a driven fit. They do not slip loosely into the hole. They are driven into the hole.

Senator STENNIS. All right. Proceed with your statement.

Commander FOSTER. These dents were in the nature of 10 inches deep, 6 feet wide, and 10 feet in length. This was repaired by placing steel reinforcing in the concrete lining of the legs in the dished areas.

The tower erection was completed without further incident and was accepted by the Navy for delivery to the Air Force in November 1957.

The following summer the Air Force reported that the tower had commenced to move excessively. Divers were thereupon hired and positioned for underwater inspection and tightening of any loose bolts at the earliest. The contractor was consulted when the divers reported that one pin was loose and one retracted on the K position or angle on the lateral brace at the 25-foot level, and that the collar on the B leg showed evidence of movement. He agreed to perform required correction at his expense, including replacement of the Dardelet bolts with T bolts in the collars. By so doing, we made certain that the collars were tight and would remain so. This project, which was constantly inspected by divers during and after the performance of the work, was satisfactorily completed in May 1959.

NAVY NO LONGER DIRECTLY INVOLVED IN TOWER NO. 4 PROBLEMS

From that point on the Navy performed no more service at the site in connection with Texas tower No. 4, and I was detached on July 1, 1959, to go to my present duty station.

I was, to say the very least, shocked by the subsequent course of events and I come before you today both as sorrowful and as anxious to find the answer as anyone here present.

Senator STENNIS. Well, that is a very fine statement, Commander Foster.

Shall we let counsel proceed now, Senator, for about 20 minutes? He has these points in mind. If you have to go in the meantime, we shall yield to you at any time.

Senator SALTONSTALL. Mr. Chairman, I expect to be here for another 20 minutes at least.

Senator STENNIS. Does that suit you all right?

Senator BARTLETT. Yes.

Mr. KENDALL. Commander, at what time did your tour of duty commence in Boston?

Commander FOSTER. I would like to refer to the record. It was either late in November or early December in 1956.

Mr. KENDALL. When did you take over responsibility for Texas tower No. 4?

Commander FOSTER. At approximately January 1, or a day or two before, when Captain Albers was detached.

Mr. KENDALL. January 1, 1957?

Commander FOSTER. Yes, sir.

Mr. KENDALL. Who were your immediate superiors?

Commander FOSTER. They varied. Captain Randig, the district public works officer, was my principal superior. His deputy was Captain Plichta.

Mr. KENDALL. Were there any others during your tour at Boston?

Commander FOSTER. Upon Captain Randig's retirement in June 1957, Captain Plichta was elevated to the position of officer in charge of construction. Captain Thomas White became the deputy, although I am not certain that this occurred simultaneously. Captain Plichta later retired and was relieved by Captain Husband.

I would like to refer here for the date, sir. I do not have that in my head.

Mr. KENDALL. I think that will be sufficient, Commander.

Did your authority as the officer in charge of construction include the approval or disapproval of requested change orders in design and construction procedures?

AUTHORITY OF OFFICER IN CHARGE OF CONSTRUCTION DEFINED

Commander FOSTER. My authority, sir, was rather defined in the negative. It was all of the authority possessed by the officer in charge of construction except that which he was not allowed to delegate by law. These items concern matters other than of a technical nature.

Mr. KENDALL. If you will excuse me, Commander, that answer to me is not responsive, because I do not know what the duties of the officer in charge of construction are.

Commander FOSTER. I am sorry, Counsel.

Mr. KENDALL. So if you will answer specifically as to whether or not your authority included the power to approve or disapprove change orders requested during the course of construction, I will appreciate it.

Commander FOSTER. I believe that the change order itself was signed by the officer in charge. However, the preparatory work in connection with it was done by myself.

Mr. KENDALL. Did you have the authority to make that decision yourself without reference to higher authority?

Commander FOSTER. I considered that I did, and in those cases where I did, it was never questioned.

Mr. KENDALL. Now, you had nothing to do with the change whereby the temporary platform was eliminated and the permanent platform was substituted?

Commander FOSTER. I did not, sir.

Mr. KENDALL. Did you have anything to do with the change whereby the driven pilings were eliminated?

Commander FOSTER. No, sir.

Mr. KENDALL. The principal change, as I understand it, which you approved, was the increase of the tolerances in the pin connections, is that right?

Commander FOSTER. That was one, sir.

Mr. KENDALL. What were the other principal changes that you approved?

Commander FOSTER. Well, the substitution of the braces, as I said in my statement, sir.

Mr. KENDALL. Well, with reference to the pin tolerances, I believe the original design was one sixty-fourth of an inch, is that correct?

Commander FOSTER. That is basically correct.

Mr. KENDALL. Now, what were the changes subsequently made and approved by you?

Commander FOSTER. An increase to a maximum of one-sixteenth in all cases except what amounted to the top panel bracing, in which case, one-eighth.

Mr. KENDALL. Will you point out on the model the top panel that you refer to?

Commander FOSTER. That would be this whole plane of bracing at the −25-foot level; these connections [indicating].

Mr. KENDALL. In other words, you permitted an increase to one-sixteenth inch in all pin connections on the tower except the top level of bracing, in which you permitted an increase to one-eighth inch; is that right?

Commander FOSTER. That is right, sir.

Mr. KENDALL. What was the reason for increasing those tolerances?

Commander FOSTER. As I mentioned in my statement, sir, the contractor had experienced considerable difficulty in trying to make up these connections, and as I am sure you can realize, when you are trying to insert an 8-inch pin, which may weigh 300 to 400 pounds 125 feet in the air through five layers of plates, with one sixty-fourth inch difference in diameter between the hole and the pin, this is a difficult situation. However, before approving this, we had considerable thought and consultation with the architect-engineer and with full knowledge that this might have some effect on the structure, for which reason I took it up with the architect-engineer; I did refer to him, and after his approval and based on my own assessment of it, I granted that approval.

Mr. KENDALL. Did you have any reluctance, hesitancy or doubt about the wisdom of granting that increase in tolerance?

Commander FOSTER. I did not, sir.

Mr. KENDALL. As an engineer, do you not believe that the increase in the tolerance to one-eighth inch permitted some motion in the tower as erected?

Commander FOSTER. Well, it certainly would permit more motion than a smaller tolerance would; yes, sir.

Mr. KENDALL. So that it actually permitted more motion than was called for by the original design, is that correct?

Commander FOSTER. I would say that would be a true conclusion; yes, sir.

Mr. KENDALL. Would it be reasonable to assume that with the passage of time the motion of the sea and the sway of the tower, the impact of the pins as they fetched up would increase the wear and the tolerance?

Commander FOSTER. I am not sure, sir, that impact is the essential element here.

Mr. KENDALL. Well, I may be using incorrect terminology engineeringwise, Commander; I am sure you understand the essence of my question, so will you please answer on that basis?

Commander FOSTER. I think theoretically; yes, sir.

Mr. KENDALL. As a matter of fact, it is no longer theoretical in the case of Texas tower No. 4, is it?

Commander FOSTER. I am familiar with it up until the time I left the project, sir, but although I have read some of the recent developments, I am not particularly sure on the latter part.

Mr. KENDALL. You are fully aware of what happened from the history that has been given to you, are you not?

Commander FOSTER. Yes, sir.

Mr. KENDALL. In your judgment as an engineer, would not the fact that it was found that the tolerances had increased to 1 inch substantiate the judgment that this was caused by the motion of the tower and the motion of the sea and the fetching up of the pins?

Commander FOSTER. I am sorry, sir, I got lost in that question. But I would like——

Senator STENNIS. He will restate it if you got lost.

Mr. KENDALL. I may be lost, myself.

TOWER MOVEMENT AND IMPACT OF PINS FETCHING UP DEEMED NOT RESPONSIBLE FOR DETERIORATION IN PIN TOLERANCES

Based on the history that you have received, and including the fact that it was subsequently developed that the tolerance in the pins, as a result of an actual observation and inspection, had in some cases increased to 1 inch, would it be your judgment as an engineer that that was caused by the fact that the tower was moving and by the impact of the pins fetching up?

Commander FOSTER. It would not, sir.

Mr. KENDALL. What would be your judgment on that question?

Commander FOSTER. If I may review as briefly as I can the history of these braces and pins, I shall try to answer the question. I cannot do it in a sentence or two, however.

These braces were installed in the latter part of August and early September of 1957. The tower was delivered to the Air Force in November 1957. In the fall of 1958, we were advised by the Air Force, and I believe it was the occupants of the tower, that they had noticed excessive motion and we immediately engaged a firm of divers, the Marine Contractors, Inc., to inspect these braces and, in particular, the collars were what we had in mind, because we felt some of the bolts might be loose, but also the pins at the 25-foot level. They did so, and I believe they worked in September or October of 1958. Their report was made in November.

Now, this report a year after, or a little better than a year after the braces were installed and the tower was in place, showed no evidence of wear on any pins. It did mention one loose bolt, for which I think there was an obvious reason: The collar at the other end was riding, and therefore, this bolt was not fetching up, so to speak.

WEAR IN PIN CONNECTIONS NOT PERCEPTIBLE FOR YEAR

But in the record, the evidence is that for a year, at least, no wear was perceptible. We started repairs, but bad weather forced us to cease. We picked up again when weather permitted in the spring,

tightened up the through bolts, and substituted other bolts for the Dardelet bolts.

But I get back to the point of wear. Up to that time, there had been no evidence of any unusual wear. That was the reason for my negative answer to you.

Mr. KENDALL. That was within 1 year after the tower went into operation that you are talking about?

Commander FOSTER. A little more than a year, sir.

Senator STENNIS. What was the approximate date of this inspection? You said you turned it over to the Air Force in December of 1957?

Commander FOSTER. November, sir.

Senator STENNIS. Well, you refer then to a subsequent inspection; when was that inspection made?

Commander FOSTER. This inspection that I referred to was made, I believe, in September or October of 1958, and the report was dated in November of that year.

Senator STENNIS. All right.

Mr. KENDALL. Commander, were you present when this tower or template was towed to sea for the purpose of erection?

Commander FOSTER. I was present at Portland when it was towed out of the drydock, and I was present at the site when the tow arrived.

Mr. KENDALL. Do you recall what the design criteria were for the stress to be encountered during the tow?

Commander FOSTER. As I recall, it was a 15-foot wave and a 50-knot wind. However, this is out of memory, and if it is critical, I would like to check it.

Mr. KENDALL. Was the criteria exceeded during the tow?

Commander FOSTER. Not to my knowledge. Of course, I was not with the tow.

Mr. KENDALL. What were the weather conditions during the tow? were any storms encountered?

Commander FOSTER. There were conflicting weather reports received. I have here excerpts from inspectors' reports, which I would be glad to read if you desire.

Mr. KENDALL. Well, Commander, you referred in your statement to a storm that was encountered during the tow, and that there was rough weather following it.

Commander FOSTER. This was not precisely during the tow, sir. It was after the tow arrived out on the site. There was a storm.

Mr. KENDALL. Was the tower then still in a horizontal position, or had it been upended?

Commander FOSTER. It was then in a horizontal position.

Mr. KENDALL. And what were the wind and waves during that storm? Did they exceed the criteria, or did they not?

Commander FOSTER. In my opinion, they did not come close to it.

Mr. KENDALL. Now, when you discovered the diagonal braces to be broken during or after the tip-up process, were any discussions held by you with reference to what should be done or whether the tower should be taken back to port for repairs?

Commander FOSTER. There was considerable discussion about the effect these braces might have, sir, but as I said in my statement——

Mr. KENDALL. Just a moment. Who participated in those discussions?

Commander FOSTER. I am going back 4 years, sir, and I would hesitate to pinpoint any particular person or particular place to identify what I shall call a general discussion.

Mr. KENDALL. Well, you participated in it?

Commander FOSTER. As far as I am concerned, sir, the only discussions that I had that had any meaning whatsoever were with Mr. Steers, who represented the contractor, and Dr. Rutledge, who represented the architect engineer.

Mr. KENDALL. Did you discuss then whether or not you should attempt the repairs on the site or return the tower to port for repairs?

Commander FOSTER. I am sure that this subject came up, sir.

Mr. KENDALL. Commander, do you not know it came up?

Commander FOSTER. Yes, sir.

Mr. KENDALL. Did anyone, during the course of that discussion, make a suggestion or recommendation that the proper thing to do would be to return the tower to port for repairs?

Commander FOSTER. A suggestion may have been made. It did not emanate from either of the two people whom I said previously were the ones whom I was primarily doing business with.

Mr. KENDALL. Who made the suggestion?

Commander FOSTER. I do not recall that it was made, sir, but it may very well have been.

Mr. KENDALL. Do you say it was made or it was not made?

Commander FOSTER. I say I do not recall such a suggestion having been made, but it may very well have been. But there was, as I say, considerable discussion on this subject at the time.

Mr. KENDALL. But your testimony here is that neither the architect engineer nor any of his representatives nor the contractor nor any of his representatives made such a suggestion or recommendation?

Commander FOSTER. As I stated in my statement, sir, we discussed the possibility of putting in the permanent replacement brace, and agreed it could be done. This was the hinge on which the return to port would have to turn.

RECOMMENDATION FOR RETURNING TO PORT FOR REPAIR

Mr. KENDALL. Now, we shall go back to my question I asked a minute ago.

Commander FOSTER. Yes, sir.

Mr. KENDALL. Is the answer to my question "yes" or "no?" I asked whether you state here today that neither the architect engineer nor the contractor nor any of their representatives made any suggestion or recommendation that the tower be taken back to port for repairs. That is my question.

Commander FOSTER. That is a rather general question, sir.

Mr. KENDALL. That is a very specific question, sir.

Commander FOSTER. It requires me to go back a long time in time. I do not recall such a suggestion or recommendation. I am positive, in the recollection of my memory, that it was not made by Dr. Rutledge or Mr. Steers.

Mr. KENDALL. Can you extend your answer to Mr. Kuss or Mr. Rau?

Commander FOSTER. I do not believe Mr. Kuss was on the tower at that time, sir.

Mr. KENDALL. That is not my question, Commander. I asked if you would say that they did not make that suggestion or recommendation?

Commander FOSTER. I would not say, but I do say further that had Mr. Rau made it, I do not believe I could have received it. Mr. Steers, the head of the company, was on board and he would certainly speak for the contractor.

Mr. KENDALL. You will agree that the loss of these braces was a serious problem and a serious defect in the tower and a mishap?

Commander FOSTER. I agree it was a serious problem. I would not agree that it was a serious defect.

Mr. KENDALL. You do agree it was a serious problem?

Commander FOSTER. It was one that required serious consideration, and got it. It was a problem, but not, shall I say, a fatal or vital one.

Mr. KENDALL. The vital decision, then, was whether or not to attempt repairs at sea under water or return to port. That was the question, right?

Commander FOSTER. I would say that would be a fair statement of it, sir; yes.

DECISION TO REPAIR AT SEA OR RETURN TO PORT

Mr. KENDALL. Who ultimately made the decision to attempt to make the repairs at sea?

Commander FOSTER. I would like to refer again to my statement, sir, that this tower was not, at that time, the property of the Navy, nor was it the responsibility of the Navy. This tower belonged to the contractor, and would belong to him until such time as he turned it over to us in an acceptable condition. And if the contractor or any of his representatives felt that, (1) it was unsafe at the time, or, (2) he would be unable to make a succesful repair at sea, it was up to him to take the tower back, not up to me to tell him to.

I did not consider it to be unsafe at the time, nor did I consider that we could not put in a successful brace. My statement was that I took no action to stopping or moving one way or another. This was his baby.

Mr. KENDALL. My question was, Commander, specifically, who made the decision to attempt the repairs at sea?

Commander FOSTER. I approved the belief, if you like, that a repair could be successfully made at sea. I believed it then, I believe it now.

As to the decision, had the contractor had any doubt in his mind, it was his move. I took my action only based on the fact that he thought it could be done, our architect engineer thought it could be done; I, myself, thought it could be done. So I allowed them to stay and go on with the process.

Mr. KENDALL. So that it ultimately was your decision?

Commander FOSTER. Yes, sir.

Mr. KENDALL. If you had told him, we have to take this tower back to port for repairs, he would have done it, would he not?

Commander FOSTER. He would have been happy to do it, I think.

FUNCTION AND USE OF DARDELET BOLTS

Mr. KENDALL. Now, you have been discussing the repairs with the use of these Dardelet bolts, Commander. Is it not true that Dardelet bolts are customarily used for a temporary repair?

Commander FOSTER. I could not answer that precisely. In my evaluation of the brace, I considered the bolt in the problem.

Mr. KENDALL. I am discussing now, generally the question of what is the function of a Dardelet bolt and what it is used for. Is it not true that customarily and generally, they are used for a temporary fix?

Commander FOSTER. I do not believe that is true, sir.

Mr. KENDALL. Do you know whether it is true or not?

Commander FOSTER. I would not hesitate to use them in permanent work. In fact, I would use them in preference to an ordinary structural bolt.

Mr. KENDALL. So you say they are used for a permanent fix?

Commander FOSTER. Yes, sir.

Mr. KENDALL. Now, after the tower was upended, Commander, I believe that the permanent platform was floated in and jacked up prior to the legs being embedded and prior to any stiffening of the legs with concrete; is that correct?

Commander FOSTER. That is correct.

Mr. KENDALL. Was that a factor which was taken into consideration in calculating the original stresses?

Commander FOSTER. I was not involved in the project during the calculation of the original stresses, sir. I really do not know, but I would not—I am not in a position to say.

Mr. KENDALL. Will you describe by reference to the model that you have before you the damage which was sustained by the tower legs, or to the tower legs, from the platform?

Commander FOSTER. As it stands now, the dishing——

Mr. KENDALL. Just for my information, what do you mean by dishing, Commander?

Commander FOSTER. These legs, or caissons, are cylindrical. If you can imagine taking a cylinder and pushing inward on it, a slight inward deformation occurs.

Mr. KENDALL. You mean a dent?

Commander FOSTER. Not precisely a dent; a flattened effect.

Mr. KENDALL. Go ahead now and show where this happened and describe them.

Commander FOSTER. Right at the waterline on the C, and B, and the A leg, as the tower now sits.

Mr. KENDALL. Of what height and of what depth were they?

Commander FOSTER. They were approximately—they varied, but approximately 10 feet in height, approximately 6 feet in width, and I think the maximum was about 10 inches indentation in depth.

Mr. KENDALL. Did that injury give you any particular concern?

Commander FOSTER. It did at the time; more a feeling of what might have happened than what actually did.

Actually the injury was assessed to not be too serious. It was reinforced inside and repaired in that way.

Mr. KENDALL. After the tower was upended and installed and the work was completed, I believe you turned it over to the Air Force in November of 1957?

Commander FOSTER. That is right, sir.

Mr. KENDALL. Did the Navy at that time certify in writing as to the structural stability of the tower?

Commander FOSTER. We filled out the usual forms, sir, and I am sure, in turning it over, it was understood that this tower was as specified, et cetera.

Mr. KENDALL. Do you have a copy of that instrument with you? If so, will you make it a part of the record?

Commander FOSTER. Yes, sir; we do, and I shall produce it in a moment, sir.

(The document referred to is as follows:)

TRANSFER OF CONSTRUCTION

STATION	SERIAL NO.	JOB NO.	DATE
U. S. Air Force Station, [illegible], Texas Tower #4		Eng-[illegible]	2 November 1957

TYPE OF BUILDING OR FEATURE (1)	NO. UNITS (2)	DRAWING NO. (3)	BASE DATA (Lin. Ft., Sq. Ft., Gals./Day, Etc.) UNIT (4)	TOTAL QUANTITY (5)	REMARKS (6)
Large steel self-contained	1	678245	Gross Tons	5160	The platform is triangular in
platform, comprised of		678243 -3			plan, 20 feet deep, 190 feet on
three decks including liv-		678251 -3			side and surmounted along one
ing facilities, mechanical		678271 -9			side by a deckhouse 100 ft x
and electrical services		678134 -3			60 ft x 12 ft high. The plat-
required for operation and		678149			form is supported 66 feet above
maintenance of the platform		678150 -4			mean sea level on three 10 foot
equipment for [illegible]		678167			diameter steel caissons.
and fueling, helicopter		678173			
landing and takeoff, to be		678180	Diesel Fuel		
used as an off-shore radar		678136 - 678147	gallons	433,000	
station		678201 - 678[illegible]			
		678243 - 678272	Fresh Water	36,000	
		678284	gallons		
		and revisions			
		thereto	[illegible]	3,250	
			Air Cond. Tons	230	
Authorizations:				Costs shown for compara-	Total Costs
Public Law 534 (82) $24,000,000				bility purposes only	$[illegible]
Public Law 161 (4) $8,000,000				Final costs not yet	Funds FY-Const.
Appropriations				determined.	Approp. AF
57 x 3300 Project No. P-321, Allotment [illegible]					Expended: [illegible]

It is certified that the construction listed hereon is in accordance with contract drawings, specifications, and change orders approved by the authorized representative of the U. S. Air Force (insert name of using agency) except for the deficiencies listed on the back of the sheet. Miscellaneous items to be delivered to the using service shall be in accordance with [illegible] and Chapter IV, Orders and Regulations.

ACCEPTED BY:	CERTIFIED BY:
/s/ Wilfred [illegible], Maj — POST ENGINEER (USAF)	/s/ [illegible] — Resident Officer [illegible] in Charge of Construction
/s/ Reginald [illegible] — COMMANDING (Date)	/s/ [illegible] — Assistant Officer in [redacted] Charge of Construction

ENG FORM 290 MAR 52 EDITION OF 1 DEC 48 MAY BE USED.

Items excluded from this acceptance:

1. Arctic tower.
2. Radome deck.
3. All stairwells.
4. Painting of all doors.
5. Main deck compartments 9 and 11.
6. Second deck compartments 102, 109, 176, 181, 182, 183, and 184.
7. Reentry maintenance scaffold.
8. Trunnion-type hose reels for hot salt water hose.
9. Heat exchangers 5 and 6 with associated piping.
10. All floor tile.

Construction deficiencies:

1. Complete the Sage changes in the arctic tower and on the main deck.
2. Complete touchup of interior painting.
3. Furnish missing keys and repair broken locks.
4. Complete one coat of paint on the exterior of the deck house.
5. Touch up exterior painting.
6. Furnish tags for valves.
7. Repair insulation in rooms 226, 201, 229, and 19.
8. Complete the painting inside C leg.
9. Replace windows spattered with weld.
10. Install flame arresters on leg purge fans.
11. Replace cable on 2-ton hoist.
12. Install missing nameplates.
13. Furnish all materials not presently on board and inventory all items furnished by the contractor.
14. Furnish radio interference suppression certificates for diesels and boilers.

The contractor agrees that the above construction deficiencies remain in the accepted portions of Texas tower No. 4, for the contractor to cover at no further cost to the Government and will be corrected on or before December 15, 1957.

The contractor further agrees that all items excluded from this acceptance will be completed on or before December 15, 1957, at no further cost to the Government, except as resolved prior to the acceptance of these items.

/S/ Steve J. Poulos
Lt. (jg) S. J. Poulos,
(For the U.S. Navy).

/S/ E. Larson
Mr. E. Larson,
(For the Contractor).

/S/ Reginald L. Stark
Capt. Reginald L. Stark,
(For the U.S. Air Force).

Certified to be a true copy.

Mr. Kendall. Now, prior to turning it over to the Air Force, and after the completion, was an underwater inspection made of the tower?

Commander Foster. No, sir.

Mr. Kendall. Why not?

Commander Foster. It was not considered necessary at the time, or indicated.

Mr. Kendall. But none was made.

Commander Foster. None was made.

TOWER MOTION CALLS FOR INSPECTION

Mr. Kendall. One was subsequently made, I understand, because of the motion of the tower.

Commander Foster. That is right.

Mr. Kendall. And in that inspection it was found that the Dardelet bolts were not holding the collar in place; is that correct?

Commander FOSTER. That is right, sir.

Mr. KENDALL. Now, did you contact Moran, Proctor, the architect-engineer, about that situation?

Commander FOSTER. Moran, Proctor were kept in close touch with all developments that had any structural significance on the tower.

Mr. KENDALL. Did you have any written communication with them?

Commander FOSTER. I believe we did, sir, but I cannot be sure. We did a lot of telephone business; we consulted together, we wrote back and forth. I am positive that we consulted in this case, but I cannot recall.

Mr. KENDALL. Will you check and see if you do not have a letter to them and a reply from them with reference to the situation?

Commander FOSTER. Yes, I have a letter from Moran, Proctor to the officer in charge, dated December 5, 1958.

Mr. KENDALL. Was that in reply to a letter that had been written by you?

Commander FOSTER. It refers to a letter of December 2, 1958.

Mr. KENDALL. Will you make both of those part of the record, please, Commander?

Commander FOSTER. Yes, sir. I think one we shall have to produce, sir. We have the December 5 letter here.

Mr. KENDALL. You may furnish that.

Senator STENNIS. All right. Those letters will be made a part of the record.

(The letters referred to are as follows:)

DECEMBER 2, 1958.

MORAN, PROCTOR, MUESER & RUTLEDGE,
415 Madison Avenue,
New York, N.Y.

GENTLEMEN: Your letter of 28 October 1958 states that the scheme indicated on Steers Morrison, Knudson sketches showing details and arrangements of the T bolt for fastening the collar of the replacement brace to the A leg of TT 4 will result in the best possible solution of the problem fixing the collar to the leg.

However, this office has been requested by the Air Force to issue a statement in writing advising if the stability of TT 4 will be as secure after the repairs are made to the collar at A leg as originally designed or more specifically will the high tensile T bolt now being installed make a more secure connection than that provided by the Dardelet bolts. An early reply will be appreciated.

Very truly yours,

JOSEPH G. A. RICCIO,
Assistant to ROICC.

DECEMBER 5, 1958.

OFFICER IN CHARGE OF CONSTRUCTION,
TEXAS TOWERS NOY CONTRACTS
Navy Building,
495 Summer Street, Boston, Mass.

DEAR SIR: We have your letter of December 2, 1958, requesting a statement regarding the adequacy of Texas tower No. 4 bracing after affixing the collars of the replacement with the new high tensile T-bolts. We believe that, when the present program of retightening the main bolts and installing the T-bolts to the proper tension at the connections at the bottom of the two diagonal replacement braces is completed, the structure will be as strong or stronger than with the original arrangement utilizing the Dardelet bolts and that the bracing thus restored will be substantially equivalent to the original design.

In the original design we had complete freedom as to arrangement of structural members making up the connections and were able to establish the correct working points for the intersections of the members, but we were unable to achieve such conditions with the replacement braces due to various interferences. Therefore there exist some secondary stresses which are not present

in the original design. We have estimated the importance of these stresses and find that percentagewise they do not greatly affect the overall strength of the panel involved, but nevertheless there is some decrease in the factor of safety and it can be said that, had the loss of the original braces not occurred, we would have had a more perfect structure strengthwise.

We do not believe that the replacement connections affect the rigidity.

Very truly yours,

MORAN, PROCTOR, MUESER & RUTLEDGE,
THEODORE M. KUSS.

Mr. KENDALL. Was that difficulty that was ascertained as a result of the underwater inspection treated as a design deficiency, or as a construction deficiency?

Commander FOSTER. Construction deficiency, sir.

Mr. KENDALL. At whose expense were the T-bolts installed?

Commander FOSTER. At the contractor's expense.

Mr. KENDALL. No additional allowance was made to the contractor for any work in connection with that?

Commander FOSTER. He did some work at the time with regard to an oil leak, which I believe we did allow. But the repair of this brace, he did.

Mr. KENDALL. Commander, do you have a T-bolt in front of you there, so we shall know what we are talking about, and tell us briefly how you would install this?

Commander FOSTER. I think we have a sketch here that showed the specification for installing this bolt. May I refer to it?

Mr. KENDALL. Yes, sir, you may.

Commander FOSTER. Our problem here, of course, was that we could not get into the inside of the caisson. Horizontal slots were cut through the collar, through the skin of the caisson, which would permit the entrance of the T-head in a horizontal position, after which it was rotated to the vertical, which brought it in bearing up against the caisson skin or the leg skin, and the nut tightened up to a predetermined torque.

Mr. KENDALL. Just to go back for a moment, there is a memorandum from Captain Husband with reference to this matter, which states that it is not considered that the contractor is obliged to provide the alternate T-bolt installation on this leg without extra reimbursement.

Commander FOSTER. I recall that letter, sir.

Mr. KENDALL. So with reference to replacing the Dardelet bolts with T-bolts, that was not treated as a construction deficiency; is that right?

FAILURE OF COLLAR CONNECTION WITH DARDELET BOLTS TREATED AS CONSTRUCTION DEFICIENCY

Commander FOSTER. Yes, it was, sir. There is maybe a little point here that should be clarified.

The contractor was required to install the brace with the Dardelet bolts originally shown, which he did. Hewing very close to the line, when we sent him back in there to fix it, theoretically he should properly have installed the Dardelet bolts.

However, this could not be done. The holes were outsize. Another means had to be found. He was willing to install the T-bolts, which we felt were equal, if not better than the others, so he agreed to install the T-bolts. However, in our letter to the Air Force, we were not

sure at that time but what he might make an objection to that installation.

He did not; later he installed it.

Mr. KENDALL. Will you make that memorandum or a copy of it a part of the record? I think it is dated December 4, 1958.

Commander FOSTER. Yes, sir.

(The memorandum referred to is as follows:)

DECEMBER 4, 1958.

From: District Public Works Officer, 1st Naval District.
To: U.S. Air Force Installations Representative Office, New England region, building 112, south, 424 Trapelo Road, Waltham 54, Mass.
Subject: Texas tower No. 4; stability and deficiencies.
Reference: (*a*) AFIRO, NER 1tr GEN/CPS-1 of November 21, 1958.
Enclosures: (1) Copy of inspection report dated November 25, 1958, made by Marine Contractors Co., Inc.
(2) Sketch showing T-bolt replacements—two sheets.

1. Enclosure (1) is furnished herewith as requested by reference (*a*). The inspection covered by the report was carried out September 12, 1958, through October 5, 1958.

2. Beginning November 1, 1958, repairs in the area of the dardelet bolts on the A caisson were begun. These repairs consist of the substitution of 40 specially fabricated T-bolts for the 78 dardelet bolts originally installed. It is considered that this installation when completed will be superior to the dardelet bolts in that it will be better able to withstand the tendency to work loose indigenous to subject structure.

3. Adverse weather has impeded progress of the repair work to date. Out of 27 days it has been possible to make only 16 dives. Out of the last 13 days only 2 dives were possible. It is estimated that approximately 50 percent of the scheduled work has been accomplished to date, consisting principally of cutting slots for the new bolts. No bolts have been installed; it being considered desirable not to place the bolts until all slots are ready to receive them.

4. Concurrent with the work of repairing the A leg collar the Marine Contractors Co., Inc., has conducted a detailed inspection of the dardelet bolts at the B leg collar. A copy of the report of this inspection will be forwarded when received.

5. Concerning responsibility for the troubles encountered at the collars the following conclusions are submitted:

(*a*) *"A" leg dardelet bolt failure.*—Responsibility not determinable. Although there is reason to believe that the contractor may not have installed these bolts in accordance with the plans, there is no way to demonstrate this conclusively at this time. Conversely, it is possible that the bolts were correctly installed. (Refer to enclosure (1).)

(*b*) *"B" leg dardelet bolts.*—Although no failure was observed, approximately half the bolts were loose and could be extracted by hand. Interim reports from Marine Contractors Co., Inc., to date establish that bolts are not all of design diameter and length, and some holes are oversize. This is considered to be a construction deficiency. The contractor has verbally agreed to make the proper installation as soon as weather permits in the spring. It is not considered that the contractor is obliged to provide the alternate T-bolt installation on this leg without extra reimbursement although as previously stated, the latter design is believed to be superior. It is intended to provide diver inspection under Navy contract after the original contractor completes repairs contingent upon the availability of funds to finance such inspection.

6. As indicated by enclosure (1) there is still an oil leak in the "A" caisson, in an area covered by the collar. It is possible that a hole similar to the one already plugged exists in which case a construction deficiency is indicated. It is also possible that the leak is through the housing on the interior of the caisson to accommodate the dardelet bolts, in which case a design deficiency is indicated. Based upon interim reports of the current inspection the latter alternative appears more probable. Unless a hole in the caisson is discovered during the course of the repair to the collars it is considered that the leak will have to be accepted. Although no firm estimate of cost to remedy the leak is possible at this time, it is believed that this cost will be exorbitantly high. If the using agency can operate without the storage provided by the "A" leg caisson, it is

felt that this would be the more practical and economical solution. It is noted that without the storage provided by this leg, the tower would have a capacity of 2½ months' fuel with the increased demands envisioned in the pending modifications.

7. Your views on the foregoing analysis are solicited.

A. C. HUSBAND.

Copy to: Cdr., 4604th SUPSQ, Otis AFB, Mass, w/incl.

Mr. KENDALL. When were these bolts finally installed?

Commander FOSTER. It was in the spring of 1959, May or June, I believe.

Mr. KENDALL. Did the Navy then again certify in writing to the Air Force that the tower had been restored to its original design strength?

Commander FOSTER. Substantially so.

Mr. KENDALL. Was that in writing?

Commander FOSTER. I believe it was.

Mr. KENDALL. You have a written communication to the Air Force from the Navy certifying to the structural stability of the tower, is that correct?

Mr. EDWARDS. Yes, sir.

Mr. KENDALL. Would you make that communication a part of the record?

Mr. EDWARDS. Yes, sir.

Mr. KENDALL. Had you, prior to that time, received any communication in writing from the architect-engineer with regard to the certification?

Mr. EDWARDS. Yes, sir.

Mr. KENDALL. Will you also make that a part of the record, please?

Mr. EDWARDS. Yes, sir.

(NOTE.—Certification took the form of formally transmitting to the Air Force a copy of the design and construction report on page 64 of which appeared the following statement:)

A repair program carried out during the summer of 1959 provided for tightening the main bolts to draw the collars tightly around the tower legs and the installation of T-head high-strength bolts through slots burned in the legs to form a tight and secure connection between the collars and the tower legs. It is belived that these repair operations have secured the replacement braces and that the foundation structure is now operating in close approximation to the original design condition.

Mr. KENDALL. Now, just one further question, Commander.

To go back to these pin tolerances, in view of the looseness or the slack in the Dardelet bolts, is it not your opinion that there would have been a deterioration in the pin connections from impact until such time as these T-bolts were installed?

Commander FOSTER. Well, as I stated previously, Mr. Kendall, an examination was made a year after those braces were installed, and no evidence of such wear was found. I do not—I shall stand on that.

Mr. KENDALL. Was an inspection made of the pin tolerances throughout the tower at that time?

Commander FOSTER. Just at the upper level of bracing. However, I believe this was considered the critical one so far as tolerance went.

Mr. KENDALL. Did the architect-engineer—that is, the Moran, Proctor firm—did they give a new criteria of wind and wave forces before the T-bolts were installed?

Commander FOSTER. Yes, they did.

Mr. KENDALL. Is that the letter I have already asked you to put into the record?

Commander FOSTER. I think so, sir.

(NOTE.—The letter in which new criteria was given, reads as follows:)

NEW YORK, N.Y., *July 3, 1958.*

Subj: Movement and stresses in Texas towers.

Ref: OinCC letter April 18 transmitting Report on Measured Oscillations of TT-4.

OFFICER IN CHARGE OF CONSTRUCTION,
Texas Tower NOy Contracts, Navy Building, 495 Summer Street, Boston, Mass.

DEAR SIR: We had hoped that the oscillation frequency count made on TT-4 and submitted to us with the referenced letter might furnish some information as to the general behavior of the tower, and a possible clue as to the functioning of the new diagonal struts which were placed on the tower in the upper panel of the A-B side to replace those lost in transit during construction. We thought that perhaps, by comparing the period as measured, with the theoretical period of the elastic structure, we could definitely state that the braces were effective. Unfortunately the field measurements were not made in severe weather as the maximum reported height of swells during the observations was 15 feet and the wind velocity only 25 knots. The period of the movement reported at the same time was between 15 and 18 cycles per minute and there seemed to be no definite correlation between the period and the wave or wind condition. Our analysis shows that, with the bracing working, the period of oscillation should be between 26 and 46 cycles per minute and without the bracing being effective, rigidity would be reduced so that the period should be between 16 and 19 cycles per minute. The ranges mentioned cover various assumed ranges of compressibility of the sand foundation.

It can be seen that the measured frequencies agreed pretty well with the calculated frequencies for the condition of the bracing not being effective and it might be at first assumed that such was the case. However, as before stated, the conditions were not very severe and, for such as they were, the total movement was probably not enough to take up the specified tolerance in the fit of the pins in the pinholes so that, although the braces may not have been effective during the conditions prevailing when the oscillation count was made, more severe weather conditions with a larger potential sway might cause the pins to engage and result in a shorter period. Thus the frequencies measured proved nothing conclusively. Similar measurements during a severe storm would possibly be more fruitful. For the record, a very condensed summary is attached. Figure 1, which shows average measured frequency plotted against wind velocity. Table 1 shows conditions assumed for computations of theoretical frequencies and a summary of our calculations. In the above discussion, torsional oscillations were not considered, as the periods for this type of motion are completely out of the significant range.

As a result of your verbal request we also investigated the ability of the tower legs and bracing to withstand natural forces in case the replacement braces were loose at the lower connections or rendered useless for other reasons. The results of these computations are shown in table 2. It will be noted that two sets of computations were made: (1) to see how much of a wave could accompany 125-mile-per-hour wind and (2) to see what magnitude of wind and wave could be tolerated if combined in accordance with the formula shown and defined at the head of table 2. It will be seen from an examination of the table that, for both sets of conditions, the weakest link in the entire system is in the legs at elevation minus 75 which is at the top of the highest panel of bracing assumed (for purposes of this investigation) as working. The most pertinent figures of this table are emphasized with an extra box around them. The following facts are to be commented on:

(1) Without any wave and without exceeding the basic stress of 20,000 p.s.i., the tower should withstand a wind of 96 miles per hour. This is too favorable a condition to be expected over a long period of time.

(2) With the steel permitted to go to the yield point the tower should withstand forces from two combinations, viz:

(*a*) A 125-mile-per-hour wind with a 36-foot wave.

(*b*) An 87-mile-per-hour wind with a 67-foot wave.

The tower was designed for a 60-foot wave accompanied by a 125-mile-per-hour wind while at the same time the maximum allowable stress was permitted to increase one-third above the basic stress.

It would seem entirely possible to get a 125-mile-per-hour wind as this is not rare in tornadoes or hurricanes and it must be assumed that the maximum wave either preceded, or lagged behind, the maximum wave gust, which is a more or less likely supposition.

In any case it is of considerable concern to think of the tower having to sustain the impact of a hurricane without the upper bracing in place. We still recommend a diver inspection of this tower with special attention being given to the bolted collars which had to be substituted for the destroyed connections at the lower ends of the upper diagonals on the A–B side. Since these diver programs are difficult and costly to organize, the diver should probably go out with equipment suitable for tightening the collars if they should be found to be loose.

With regard to the often discussed program for measuring deflections of this and other Texas towers, it can be said that information on the motion is desirable from the standpoint of Air Force operations and for safety reasons. Actually, the type of information which is needed for the latter probably differs quite appreciably from that required for technical considerations involving signal reception. A third purpose for recording motion would be a purely scientific one involving correlation between wave and wind data, tower motion, and tower stresses. A program to fit this third objective would be extremely comprehensive and very difficult to sustain, due mostly to personnel problems associated with the relative remoteness of the towers. The instrumentation, particularly the wave-recording instruments, would be difficult to maintain. It is possible, however, that, with the assistance of the Hydrographic Office, some sort of limited program might be set up which would result in wave force information. It should be mentioned that equivalent information might be more directly and accurately obtained if the complexities of tower strain and motion were not involved. This sort of investigation is, however, a subject aside from measurement of tower motion and accompanying strain.

For indications of structural distress in a tower during severe meteorological conditions a minimum instrumentation should provide for measurement of tower deflection over separated periods and limited to times when tower motion might be thought alarming or for other special reasons. Measurements of translation in two directions would be made at a location as near as possible to the geometric center between the legs and no attempt made to measure rotation. This would resemble in purpose the program undertaken on TT–2 by the Lincoln Laboratories in 1956 but would be set up with a somewhat different approach. Whereas, they were concerned with small movements, and also rotation, the new purpose would be to measure larger general movements of translation only. Their approach to the problem was to correlate readings of strain gages installed on the legs with seismic accelerometer readings so that the strain gage readings could, at any subsequent time, be used to estimate the motion. This method was not too successful mostly because the strains were too small during the calibration periods and too small, in any case, to measure the motions in which the sponsoring parties were interested. Also, the strain gages and associated lead wires were in extremely uncomfortable and difficult locations in the legs which greatly discouraged if not prevented maintenance. The minimum program offered here would be to have accelerometers permanently in place to measure motion in two directions only. No attempt would be made to simultaneously measure strains (and stresses) but rather these would be computed from the recorded deflections.

We investigated the instrumentation problem in 1956 and, after considerable difficulty in locating interested parties, secured a proposal from Arde Associates of Newark, N.J., for assembling and installing a system involving two accelerometers at each corner (a total of six) which, with electronic integrating elements, could be used to register translation and rotation. With the program suggested hereinbefore only two such instruments would be used, which would measure only general translation and no rotation.

The Arde proposal was sent to your office in May or June 1956 and we received a reply from the officer in charge of construction that the study was not required "at this time." You will find in the Arde Associates' proposal an

intelligent discussion on various possibilites for measurng movements and a quotation for doing the work, which we thought was quite reasonable. We believe this should be an active subject, and requires further consideration.

Very truly yours,

MORAN, PROCTOR, MUESER & RUTLEDGE,
THEODORE M. KUSS.

(Accompanying charts to above letter in committee files.)

Mr. KENDALL. That is all I have, Mr. Chairman.

Senator STENNIS. Commander, after one question, I am going to yield to Senator Saltonstall. He has an appointment which he must meet.

I want you to know that I greatly appreciate the great amount of skill that the Navy showed in the difficult task which was assigned it. I think that this is to the Navy's great credit, and to the credit of the men that were representing the Navy.

So adverse questions are not asked to discount the Navy nor the task as a whole.

REPAIR OF BRACES BETTER PERFORMED IN PORT

But, now, just as a practical matter, in getting right down to the very bottom of this thing, is it not just commonsense and practical to say that this repair job on these broken braces could have been performed much better back in port than at sea? Is not that correct?

That is the way it looks to me, and if there is some explanation to the contrary, I wish you would hit it hard.

Commander FOSTER. Mr. Chairman, I would say certainly it could be done much easier back at port.

Senator STENNIS. It would have been more effectively done?

Commander FOSTER. Generally speaking, yes, sir. But still, that would not go to prove that an effective brace could not be made at sea; certainly perhaps a better one ashore, but our problem was to replace an existing one structurally; in other words, put back a brace that we felt would do what the original brace would do if it were there.

Senator STENNIS. Well, it just looks to a layman that these braces were essential; otherwise the plans would not have called for them. As I understand your testimony, you say that is where a great deal of the stress was.

The next step is, that when they were broken, perhaps no one was at fault. There was a heavy and tossing sea, as I understand, when they were broken. However, this did call for the restoration of their full strength in the most effective way.

I get the idea that perhaps this was not done in the most effective way. Maybe it was done as well as it could have been at sea, but it was not done in the most effective way, comparing the effectiveness of repair in port with the restoration at sea.

Now, am I wrong in that conclusion?

Commander FOSTER. No, sir; I would say that the T-bolt scheme that we evolved later was superior to the original Dardelet bolts. There may be even a better way. However, I would like to reemphasize that the original brace as conceived was designed to take all of the loads that the other members would have, and I believe as far as design, a little more. Of course, you make allowances for the fact

that this had to be braced under water. It was certainly more difficult to do it at sea than it would have been at shore.

Senator STENNIS. Well, your whole concept and design to start with was to avoid making these connections under water; that is why you had the tower fabricated and connections made before you took it out there, is that not right?

Commander FOSTER. Yes, sir.

Senator STENNIS. I yield to Senator Saltonstall, and I may ask a few questions later.

Senator SALTONSTALL. Thank you, Mr. Chairman.

May I ask just a few questions, Commander? It is not clear to me what relation you had to the district public works officer.

Commander FOSTER. I was one of his assistants, Senator Saltonstall.

Senator SALTONSTALL. Who was the district public works officer?

Commander FOSTER. During the time that the tower was towed to the site, upended and installed, it was a Captain J. Plichta, now Admiral Plichta, USN, retired.

Senator SALTONSTALL. Admiral Plichta?

Commander FOSTER. Plichta, P-l-i-c-h-t-a, sir.

Senator SALTONSTALL. Did he at any time go out to this Texas tower?

Commander FOSTER. Yes, he did.

Senator SALTONSTALL. On page 3 of your statement you say:

> We military engineers do not get into the contractors operations as such. Consequently I bided my time, because I knew that the district public works officer and a representative of the architect and engineer were en route and expected shortly.

Does that mean that you were going to leave the decision as to what to do up to the district public works officer?

Commander FOSTER. Not necessarily, sir, but knowing he was coming, and as I indicated, we were not pressed for time at the moment as to whether this should be taken back or not, I meant to discuss it with him and later did.

He was delayed, however, in arriving at the tower site.

Senator SALTONSTALL. So that you took the responsibility as his assistant in charge of this particular operation?

Commander FOSTER. Yes, sir, but I would like to point out that the decision there, my decision, was not to interfere.

Counsel put the question as though it was up to me to say we should go back to port or not. I decided to not interfere with the contractor's operations. He was free to do what he wished.

Senator SALTONSTALL. Well, the next point is, if you decided not to interfere, you, as the representative of the Navy, accepted this tower in November of 1957?

Commander FOSTER. Yes, sir.

Senator SALTONSTALL. You accepted it for the Government?

Commander FOSTER. Yes, sir.

Senator SALTONSTALL. Yet, on page 5 of your testimony, you stated that the tower was not completed until May 1959. What do you mean by that, your repairs?

Commander FOSTER. Well, when we delivered it in 1957, we fully believed that it was ready for delivery. We discovered later, due to

this motion, that there had been the brace trouble indicating it had not been installed properly, we went back to the contractor.

Senator SALTONSTALL. You did what?

Commander FOSTER. We went back to the contractor and had him repair it.

Senator SALTONSTALL. But the Navy then owned the tower at that time?

Commander FOSTER. Yes, sir.

Senator SALTONSTALL. And the Navy had paid for the tower?

Commander FOSTER. Yes, sir.

Senator SALTONSTALL. So that the tower was completed and accepted for delivery in November of 1957, yet for a year and a half afterward, it was not satisfactorily completed until May 1959. During that period, the Government owned it?

Commander FOSTER. The Government had accepted the tower, yes, sir, but within a year after acceptance, we had discovered some defective workmanship, called a construction deficiency. On that basis, the contractor was called back to repair it at his expense, sir.

Senator SALTONSTALL. Now, did the Navy at any time recertify that as satisfactorily completed, or were these simply repairs after the job had been accepted?

Commander FOSTER. After these repairs were made—and they went further than repairs. It was, to a degree, a modification of the bolting. At that time, the brace was back substantially to its original strength and was so certified.

Senator SALTONSTALL. So that in November 1957 the tower was accepted by the Navy as properly completed; then it began to get into motion. You had these repairs made and the Navy again, in May 1959, certified that the tower was safe, is that right?

Commander FOSTER. It was accepted in November of 1957 as being complete and ready for use, accepted by the Navy and delivered to the Air Force.

However, the deficiencies subsequently discovered, we had the contractor come back and repair. In other words, make good on something he should have done before November of 1957.

Senator SALTONSTALL. Well, what I am trying to get at is what the Navy did in May of 1959, when the Government owned it, and had owned it for 18 months. Did the Navy again certify that the tower was safe?

Commander FOSTER. Yes, sir.

NAVY AGAIN CERTIFIES TOWER SAFE IN MAY 1959

Senator SALTONSTALL. So that in May 1959, you, as a representative of the Navy, certified that the tower was safe?

Commander FOSTER. Yes, sir.

Senator SALTONSTALL. And you say in your statement that the Navy did not do any work on this tower after May 1959. Of course, as you went out to Guam, you do not know that?

Commander FOSTER. That is true, sir. As far as I know, up until the time I left Boston, we did no further work on Texas tower No. 4.

Senator SALTONSTALL. And you left on July 1, 1959?

Commander FOSTER. Yes.

Senator SALTONSTALL. So that during the period between July 1, 1959, and January 1961, you do not know whether the Navy had anything to do with it or not?

Commander FOSTER. No, sir; I regret that. I should have clarified that. I was speaking only within the period that I was there.

Senator SALTONSTALL. Mr. Chairman, I cannot recall whether we have had any testimony on that, but I think it would be very important to find out, through correspondence, memorandum, or anything else, if the Navy performed any additional work or whether deficiences were called to the Navy's attention after July 1959.

Senator STENNIS. Gentlemen, you have heard the observation of the Senator. Would the Navy check its files to see whether any additional work was done?

Commander FOSTER. I understand that the Secretary of the Air Force made such a statement.

Senator STENNIS. We shall check with the Air Force, too, but if you will check, we would appreciate it.

Captain DAVIS. Sir, if I may make a point, the Undersecretary of the Air Force, when he testified, stated that from that time on, the Air Force took over contact with the contractors and entered into the contracts for repairs.

Senator SALTONSTALL. So that from May 1959 the Navy did nothing further on this tower?

Captain DAVIS. At the site. We may have been consulted at the district public works offices on various things.

Senator SALTONSTALL. You made no examination, no recommendation, for repairs or anything else?

Captain DAVIS. No, sir.

Senator STENNIS. I think the Senator's inquiries are very pertinent.

Commander, if you have anything covered by the Secretary's statement, that is all right.

Senator SALTONSTALL. But the Navy did certify that the Government accepted that tower in November of 1957. When this tower began to shake, the Navy was called back and recommended and supervised repairs. So that in May 1959, the witness, the commander, again certified that the tower was safe?

Captain DAVIS. Yes, sir.

Senator STENNIS. Admiral Church had indicated he wants to say something on that point.

Admiral CHURCH. Senator, I only know from hearsay and my own review of the records in connection with this that the Navy had nothing to do after the May 1959 certification. But I believe that Captain White, who is the next witness, is in a better position to absolutely certify to the committee on that matter, sir. He was a district public works officer and a deputy since that time, sir.

Senator SALTONSTALL. May I ask one more question?

Senator STENNIS. Certainly.

Senator SALTONSTALL. Why did the pin tolerances deteriorate as much as they did if it were not due to tower motion or pin slap, if you want to call it that?

Commander FOSTER. Well, I think in my previous statement, I mentioned only impact. Certainly tower motion would contribute to any

wear. My only point, sir, is that with the information I had at hand, there was no exceptional wear or any evidence of excessive wear evident.

Now, wear—a drop of water falling on stone will, theoretically, wear a little of it away. But you may not see it.

Senator SALTONSTALL. Well, let me ask this, Mr. Chairman, as a final question.

We had a witness here the other day, Mr. DeLong, who testified that he would not do this job in the manner that it was done, lifting up the legs and so on, and that he had no use for pins as such, and that if this were going to be done, it had to be a welding job. Now, did you recommend pins to straighten out this difficulty?

Commander FOSTER. No, Senator Saltonstall; I was not involved in the design stage of this tower.

Senator SALTONSTALL. But you did believe that the pins and the bolts would do the job of keeping the tower safe?

Commander FOSTER. I had no reason to question it, sir.

Senator SALTONSTALL. In other words, in your opinion, it was the decision of the contractor, and when he said he believed this was satisfactory and would keep the tower safe, you approved that suggestion or recommendation?

Commander FOSTER. This refers to the change in tolerance of pins, sir?

Senator SALTONSTALL. Would you repeat that, please?

Commander FOSTER. Does this refer to the change in tolerance between the pin and the hole?

Senator SALTONSTALL. No; it refers to the fact that pins were used rather than welding, as I understand it.

Secondly, of course, it would refer to the increased tolerance of the pin, which you approved. As a layman, I would suppose the more the tolerance, the more opportunity for wear.

Commander FOSTER. As to the first, that decision was made before I got on the job. As to the second——

Senator SALTONSTALL. How could it have been made before you got on the job?

ORIGINAL DESIGN CALLED FOR PIN CONNECTIONS

Commander FOSTER. The design was complete and the contract was let. The contractor was building a pin-connected tower when I got on the job.

Senator SALTONSTALL. But the pins were put on the braces that were separated when the tower was being put up. The admiral is nodding his head negatively. If I am wrong in that conception, I would like to know.

Admiral CHURCH. The collars were not pin connected, sir. They were connected by the Dardelet bolts, and later by the T-bolts.

Senator SALTONSTALL. I could not hear that.

Admiral CHURCH. The collars on the braces were not pin connected. They were connected by the Dardelet bolts, and later by the T-bolts on the second repair.

Senator SALTONSTALL. Then the question of pins rather than welding came in the original design?

Admiral CHURCH. Yes, sir; the original structure was pin connected on a design basis.

Senator SALTONSTALL. All right, now, either the admiral or the commander may answer, Who in the Navy approved this concept in the original design?

Commander FOSTER. I shall have to ask the admiral to answer that.

Admiral CHURCH. Senator, the design was carefully studied and was—I am speaking from my review of the record. It was carefully studied by Captain Albers, by the district public works design division, by the Bureau's design section, and approval was given by the Bureau to this pin-connected structure.

NAVY ACCEPTS FULL RESPONSIBILITY FOR DESIGN

Senator SALTONSTALL. So that as a Member of Congress sitting here trying to find out all we can about this subject, the top authority in the Navy approved this design?

Admiral CHURCH. Yes, sir.

Senator SALTONSTALL. So that would go directly back to the Bureau of Yards and Docks?

Admiral CHURCH. The Bureau of Yards and Docks accepts full responsibility for the pin-connected design, sir.

Senator SALTONSTALL. That would be the senior officer in charge at that time?

Admiral CHURCH. Whether he personally had a conference and approved it, I am not sure, sir. But I am sure that his technical people that were well qualified in this work did review it, and I am positive that he would accept the responsibility were he asked.

Senator SALTONSTALL. So that Commander Foster's responsibility lay in seeing that the original decision of the Bureau of Yards and Docks was carried out satisfactorily?

Admiral CHURCH. Yes, sir.

Senator SALTONSTALL. When he certified that it had been satisfactory in November 1957, he was working for or he was employed as the assistant in the Bureau of Yards and Docks responsible for supervising this construction?

Admiral CHURCH. He was our direct representative at the site, sir.

Senator SALTONSTALL. Then, when it was accepted and these repairs followed, Commander Foster, again as a representative of the Bureau of Yards and Docks, stated that in his opinion the repairs were satisfactorily completed.

Admiral CHURCH. Yes, sir, I understood him to say that, sir.

Senator SALTONSTALL. And the Navy had nothing to do with the job after July 1959?

Admiral CHURCH. To our knowledge we did not, sir.

Senator SALTONSTALL. But there were discussions, et cetera?

Admiral CHURCH. I believe that you will find that there were extensive informal discussions all along on this method, sir.

Senator SALTONSTALL. Informal discussions?

Admiral CHURCH. Yes, sir.

Senator SALTONSTALL. Giving advice to the Air Force?

Admiral CHURCH. To my knowledge, only general discussions, rather than specific advice, sir.

But as I indicated, I believe Captain White, who was the District Public Works Officer in Boston, and to whom any inquiries of that nature would have been directed, is the man to answer this question.

Senator SALTONSTALL. Just one more question.

Is there anything in the Navy records, Admiral, that you have gone over that would indicate any formality to these discussions?

Admiral CHURCH. None that I have seen, sir, and I believe there are none.

Senator SALTONSTALL. And nothing related?

Admiral CHURCH. No, sir.

Senator SALTONSTALL. Thank you, Mr. Chairman.

Senator STENNIS. Thank you, Senator, very much.

Commander, there is no use for us to go over ground that has already been plowed. In engineering, I never did get beyond blacksmith shop, so I know I do not have any technical knowledge on these things. But just as a practical question, now, if the pin slap and the tower motion did not cause this deterioration in the connections, and you have said that a while ago as much as one inch was found later, if this pin slap and the tower motion did not cause that deterioration, what did?

CAUSE OF DETERIORATION IN PIN TOLERANCES

Commander FOSTER. I hope that any remarks that I made was not construed to mean that motion will not cause wear. But I think the timing here is important. When did this deterioration take place? Certainly if two objects rub against each other long enough, there will be wear. But the word that was used when the question was first addressed to me was "impact."

I said I thought there were other factors which should be considered. Now, if you take a piece of sandpaper to sand a board, obviously the harder you lean on it and the more often you rub it, the more you are going to wear it. I believe it is within the realm of possibility that one serious storm would cause as much wear on a given pin there in that tower as perhaps a year of milder weather. This is not a result of computations or anything, but merely reading over the record of the inspections made and the amount of play that was found in each one.

Senator STENNIS. Well, the deterioration which was found in these connections, I believe had resulted in a tolerance as high as an inch at one time. Really that shocked me, because I know that gives a lot of leeway. Was this caused by this continual motion which was more intense at some times than others? That is what caused the wear and tear on the tower, is it not?

Commander FOSTER. Sir, I never found an inch deflection.

Senator STENNIS. I thought you used an inch a while ago.

Commander FOSTER. No, sir.

Senator STENNIS. Have you not seen the reports indicating that it was as much as an inch in places?

Commander FOSTER. I believe I have scanned them, Mr. Chairman. I have not really studied them.

Senator STENNIS. Have you not seen in those reports that the divers inspections found tolerances of as much as an inch?

Commander FOSTER. This was in the spring of 1960, I believe, sir.

Senator STENNIS. Well, now, let us see. That is in the record, is it not?

Commander FOSTER. Yes, sir.

Senator STENNIS. Now, as I say, if the looseness of these pins did not cause that deterioration and the tolerance to increase, what did?

Commander FOSTER. I would speak now strictly as an engineer.

Senator STENNIS. Well, as a professional engineer, what is your judgment?

Commander FOSTER. Certainly what caused the clearance at any time is wear, the pins against the plates or the plates against the pins.

Senator STENNIS. All right. Now, I do not know, but if it had been welded, you would not have had that rubbing and that wearing, would you?

Commander FOSTER. Well, I would not expect—no, sir.

Senator STENNIS. Well, that is the way it looks to me, and that is the way it looks to you as a professional engineer?

Commander FOSTER. By saying that, sir, I do not wish to give the impression that I do not believe that a pin-connected tower can be successfully built. But I would answer the question as I did.

Senator STENNIS. I understand that fully, but it was my concept that the welded connection does not permit the motion and the wearing, while the other does.

Mr. Counsel, do you have anything further?

Mr. KENDALL. One or two more questions, Mr. Chairman.

The fact of the matter is, Commander, that this is the type of structure that if any brace failed to function as it should, then exceptional or additional stress would be thrown upon other braces, is that not right?

Commander FOSTER. I believe you could say that generally about any structure, Mr. Counsel.

Mr. KENDALL. And if that upper diagonal did not work as it should, as apparently it did not, would not that cause the pin connection to deteriorate?

Commander FOSTER. Theoretically, yes. But I must go back to the report made in 1958, which certainly did not indicate that. It indicated that the collar had been loose for some undetermined time, but there was no apparent wear, or at least none mentioned. One pin was loose and the brace was not taken up tight, but no wear was indicated.

Mr. KENDALL. Your position is not that because it showed no apparent wear in one year, it did not happen sometime later, is it?

Commander FOSTER. Oh, no, sir.

Mr. KENDALL. That is all I have.

Senator STENNIS. Just one more question, Commander.

Refer to page 4 of your statement, will you, please? I shall read briefly one paragraph:

> After the legs and braces were in position and during the platform installation, injury in the form of perceptible denting or dishing occurred to the A and B legs caused by the rubbing action of the platform against the legs due to sea swells. These dents were in the nature of 10 inches deep—

that means that the dents penetrated into the tower leg that much, is that right?

Commander FOSTER. Yes.

Senator STENNIS (continuing). "10 inches deep, 6 feet wide"—that is 6 feet on the upright—"and 10 feet in length."

That was rather severe, was it not, and somewhat of a surprise to you?

Commander FOSTER. It was a surprise, and I was concerned about it.

Senator STENNIS. Yes. Well, you said next:

> This was repaired by placing steel reinforcing in the concrete lining of the legs in the dished areas.

You felt that the damage was corrected by putting the steel reinforcing in the concrete lining; is that right?

Commander FOSTER. Yes, sir.

Senator STENNIS. That did not give you any more trouble?

Commander FOSTER. No, sir.

Senator STENNIS. My inquiry is that I was surprised that as serious a matter as this was not anticipated and protected against in the original design. It impresses me.

What is your professional thinking on that?

Commander FOSTER. Well, I think this was an outcome of the change from the platform, the temporary platform; in other words, had concrete been able to be placed in the legs, that would not have happened. But this was impossible at this stage. It was the only way to do it, and we did it this way.

Senator STENNIS. I commend you for having made this repair so successfully. My remark was that it seemed to me that it could have been quite serious if you had not gotten to it quickly and effectively. I just thought that should have been anticipated and hedged against after you decided to change the platform plan.

Commander FOSTER. At that stage, sir, there was no way to hedge against it.

Senator STENNIS. You had to wait for the injury to occur, you mean?

Commander FOSTER. No, sir; what I mean is we picked the quietest time we could and were very careful in hauling this platform in. I understand the committee has seen a movie. The contractor's men really worked heroically in taking steps to minimize this chafing

Senator STENNIS. I was not suggesting anything to the contrary. I think this just emphasizes the fact that you had a difficult job to do and that you should have allowed sufficient margin on all these major matters. This particular trouble was due, though, to the change in the plans about the platform installation; is that right?

Commander FOSTER. In my opinion; yes, sir.

Senator STENNIS. All right; do you have anything further?

Mr. KENDALL. Yes, sir.

Commander, you mentioned a movie that was shown. I believe that movie showed that during the tipup or the tipover, the template rotated 17 degrees in one direction and, correcting, rotated back 17 degrees in the other direction. Is that right?

Commander FOSTER. That is approximately so, sir, give or take a degree or two.

Mr. KENDALL. Was it not a fact, sir, that that was an unforeseen factor?

Commander FOSTER. It generally followed the behavior of the model study that was made.

Mr. KENDALL. Was the stress that was exerted by this rotation taken into calculation in the design criteria?

Commander FOSTER. You mean stress because of this rotation sideways rather than endways?

Mr. KENDALL. Yes, sir.

Commander FOSTER. I presume it was, but as I say, this design was already settled when I got on the job. I would think as an engineer, however, that those stresses would be much smaller than stresses that would be imposed on the structure once it was in place.

Senator STENNIS. Senator Saltonsall, do you have a question?

Senator SALTONSTALL. Just one more question. You were in no way responsible for the design, Commander?

Commander FOSTER. That is right.

Senator SALTONSTALL. You and Captain Albers were responsible for seeing that the design was carried out? I asked that question before.

Commander FOSTER. That is correct.

Senator SALTONSTALL. Now, did you have any responsibility, or did you make any recommendations as to the design, when you saw it was being carried out? Did you see any fundamental weaknesses and report them?

Commander FOSTER. I cannot recall that I did, sir. I do not believe so.

Senator SALTONSTALL. In other words, as an engineer in charge of supervising the work and seeing that it was done according to contract and design, you saw no reason to change that design due to any fundamental weakness as it was going up?

Commander FOSTER. I had no reason to feel that at all, Senator.

Senator SALTONSTALL. Thank you, Mr. Chairman.

Senator STENNIS. If counsel has nothing further——

Admiral CHURCH. Mr. Chairman, may I make a statement to correct a misimpression?

Senator STENNIS. Yes.

Admiral CHURCH. Captain Albers was the officer in charge of construction both for the design of all three towers and for the construction phases of No. 2 and No. 3. Commander Foster was the resident officer assistant, as we called him, for the construction phase of tower No. 4.

Senator SALTONSTALL. What Navy man was responsible for the design?

Admiral CHURCH. Directly, Captain Albers. Overall, the Bureau of Yards and Docks.

Senator STENNIS. He testified the other day.

Senator SALTONSTALL. Captain Albers took the responsibility. I did not realize he took it for the design.

Senator STENNIS. All right, Commander. Could you remain with us the rest of today? Matters might come up that we would want you to explain. We certainly want to thank you for coming here to give testimony. We shall appreciate it if you will just spend the rest of the day with us.

Now, as the next witness, Mr. Counsel, I understand we have Captain White.

Mr. KENDALL. Yes, sir.

Senator STENNIS. Captain, come around, please.

TESTIMONY OF CAPT. THOMAS J. WHITE, CIVIL ENGINEER CORPS, U.S. NAVY, DISTRICT PUBLIC WORKS OFFICER, FIRST NAVAL DISTRICT, ACCOMPANIED BY REAR ADM. W. C. G. CHURCH (CEC), U.S. NAVY, ASSISTANT CHIEF FOR CONSTRUCTION, BUREAU OF YARDS AND DOCKS; GORDON EDWARDS, CONSTRUCTION MANAGEMENT ENGINEER, BUREAU OF YARDS AND DOCKS; JAMES AYERS, UNDERWATER CONSULTANT; AND CAPT. WILL J. DAVIS, U.S. NAVY, LEGAL OFFICER, BUREAU OF YARDS AND DOCKS

Senator STENNIS. We are glad to have you here, Captain. Do you have a prepared statement?

Captain WHITE. Sir, I have not.

Senator STENNIS. All right, with the consent of the committee, do you wish to make an opening statement, Captain?

Captain WHITE. No, sir, other than to introduce myself. I am Capt. Thomas J. White, civil engineer, officer in charge of construction in the 1st Naval District with headquarters in Boston. I am a graduate engineer.

Senator STENNIS. How long have you been the officer in charge of construction?

Captain WHITE. I have been district public works officer, sir, since January 1, 1960. Prior to that time, going back to August 1957, I was the deputy district public works officer to Captains Plichta and Husband.

Senator STENNIS. Now, proceed with your qualifications, your professional qualifications, sir.

Captain WHITE. I am a graduate civil engineer, 1932, from the Virginia Polytechnic Institute, with a degree of bachelor of science and a civil engineering degree.

Senator STENNIS. That is very fine. That is a good start in life.

Captain WHITE. Thank you, sir.

Mr. KENDALL. Captain, at what point in time did you first have any connection with the Texas tower program?

Captain WHITE. In August 1957, when I reported in as deputy district public works officer.

Mr. KENDALL. Since January 1960, you have been the district public works officer, is that correct?

Captain WHITE. That is correct.

Mr. KENDALL. Have you had since that time any correspondence with reference to Texas tower No. 4?

Captain WHITE. Yes, I have.

Mr. KENDALL. Did you receive by mail a copy of a teletypewriter exchange dated March 1, 1960, which originated from the 551st Aircraft Early Warning and Control Wing?

Captain WHITE. I received a copy of a dispatch which had been sent from that wing to the Air Force installations representative.

Mr. KENDALL. What generally did that cover, that is, what was the subject matter and the contents?

Captain WHITE. I have a copy of that, if you would like me to read it, but it covered generally the fact that an underwater survey had been made of Texas tower No. 4, and it indicated that some repair work was necessary and that this work was of sufficient urgency in the

70733—61——11

opinion of the architect and engineer that it had to be accomplished during the coming construction season.

Mr. KENDALL. Will you make a copy of that a part of the record, please, Captain?

Captain WHITE. We shall be happy to, sir.

Senator STENNIS. It comes in the record at this point.

(The document referred to is as follows:)

MARCH 1, 1960.

Routine.
Deferred.
551st AEW&CON WG Otis AFB.
26 AIR DIV (SAGE) Stewart AFB.
Info: ADC ENT AFB.
AFRCE, NE, 424 Trapelo Road, Waltham, Mass. (Mail.)
1st Naval District, Boston, Mass. (Mail.)

Unclassified from 551IDC 0979. Action 26 AD (SAGE) for 26 IDC; Info ADC for ADIFS, AFRCE, NE. Subject: Underwater Structural Deficiencies—TT 4. This message in 6 parts. Part I: On 20 Jan. 60, 4604th SUPPRON informed this hq of excessive motion and unusual noise being experienced aboard subject tower. Underwater inspection by contract was performed on 8 Feb. Divers reported pinned joints of bracing at minus 25-ft level have horizontal motion of approx 1 inch and joints at minus 75-ft level motion of ½ inch. This motion has increased from original tolerance of ⅛ inch since May 59. Part II: Increased sway prompted meeting on 25 Feb with original structural designers of tower (Moran, Proctor, Mueser and Rutledge of New York). Info obtained from meeting indicated firm recognized sway problem and prepared design for additional bracing above sea level as part of cancelled FY61 MCP SAGE modification program. Part III: Installation of additional bracing as outlined in Part II above will present construct costs of $400,000 to $500,000 and AE costs, including Titles I & II services, $16,000. Part IV: Mr. Kuss, structural engineer of above firm, considers subject deficiency of emergency-type nature from which tower may be lost during winter storms if work not accomplished within next 5-month period. Part V: Based on previous records of sea conditions, structural bracing repairs must be completed NLT 1 Aug, requiring expeditious action in procurement, fabrication and construction phases of this project. Part VI: Complete report, including meeting minutes, being forwarded your hq under separate correspondence.

FRANCIS KAPP,
Major, USAF, D/C for Installations.

EMERGENCY CITED

Mr. KENDALL. I believe it is stated in that message that Mr. Kuss, who was the design engineer, considered the loose pin connections of an emergency nature; is that right?

Captain WHITE. That is correct.

Mr. KENDALL. And he stated further that the tower might be lost if it were not corrected by August 1; is that right?

Captain WHITE. That is my recollection; yes, sir.

Mr. KENDALL. Now, as a result of that, did you feel that some independent investigation was necessary to determine what it was all about?

Captain WHITE. I did not. At some time previous to this, I had some discussions with Colonel Cipolla, who was then the Air Force installations representative, or later became the Air Force civil engineer, with respect to some possible repair work that might be required to the tower, and the colonel asked me if we would be interested in acting as the design and construction agency for this work. Over

the telephone, and this is where most of this conversation took place, I indicated that we would be happy to act as the design and construction agency for any repair work due to structure of the tower.

Mr. KENDALL. Here is the point, Captain. Here you received this message in which the design engineer said:

> This is an emergency; if we do not do something about this tower, we may lose it unless something is done about it by August 1.

That is right, is it not?

Captain WHITE. That is correct.

Mr. KENDALL. Did you then make an independent investigation or study to determine what the facts of the situation were and the problem with which you were confronted?

Captain WHITE. No; I did not.

Mr. KENDALL. Were you familiar with it at that time to an extent that you did not need to make such an investigation or study?

Captain WHITE. No.

Mr. KENDALL. Well, did you, Captain, on March 15, write a letter about it? You did, did you not?

Captain WHITE. I did.

Mr. KENDALL. To whom was that letter addressed?

Captain WHITE. To Colonel Stephany, who succeeded Colonel Cipolla as the Air Force installations representative.

Mr. KENDALL. Do you have a copy of that letter with you, and if so, will you make it a part of the record?

Captain WHITE. I am sorry; I do not have it with me, but it will be made a part of the records; yes.

Mr. KENDALL. You will supply it as part of the record?

Captain WHITE. Yes.

(The document referred to is as follows:)

MARCH 15, 1960.

Lt. Col. R. C. STEPHANY,
U.S. Air Force, New England Civic Engineer Region,
Waltham, Mass.

DEAR LIEUTENANT COLONEL STEPHANY: Several weeks ago Colonel Cipolla discussed with me the motion difficulties being experienced by Texas tower No. 4. At that time, the basic cause for the exaggerated motion was not definitely known. However, it was suspected that it was probably due to motion of the underwater collars to which the horizontal and diagonal bracing members are attached. It was contemplated that correction of the motion difficulty would involve installation of additional bracing above the water level at an estimated cost of $500,000. I advised Colonel Cipolla that while I definitely did not wish to become involved in problems of a purely maintenance nature on the Texas towers, the motion difficulty appeared to be related to the original design and for this reason I would look favorably upon a request for the Navy to administer both the engineering and repair contracts required for correction of the difficulty.

Last week I received your memo furnishing me copies of the diving contractor's data and Otis Air Force Base request for authority to engage an architect and engineer to develop plans, specifications, and cost estimate for necessary repairs to the underwater structural bracing. However, I have not as yet received any correspondence of a formal nature which would indicate the intention of your office for the Navy to award and administer the architect and engineer contract.

If it is your intention that the district public works office award and administer the architect and engineer contract, it is suggested that formal notification

be furnished. Also, since the Otis Air Force Base request for architect and engineer authority did not mention funds, it is considered appropriate to mention that the architect and engineer fee will probably approximate $30,000 based upon the $500,000 construction estimate noted above.

With best personal regards.

Sincerely,

T. J. WHITE,
Captain (CEC) USN, District Public Works Officer.

MOTION DIFFICULTIES APPEAR RELATED TO ORIGINAL DESIGN

Mr. KENDALL. Let me read to you a portion of that letter, Captain, and see if this not correct. You stated:

I advised Colonel Cipolla that while I definitely did not wish to become involved in problems of a purely maintenance nature on the Texas towers, the motion difficulty appeared to be related—

and this is the important part—

appeared to be related to the original design and for this reason I would look favorably upon a request for the Navy to administer both the engineering and repair contracts required for correction of the difficulty.

That is a direct quote from that letter, is it not?

Captain WHITE. That is correct.

Mr. KENDALL. Will you tell the committee just what you meant by the statement that the motion difficulty appeared to be related to the original design?

Captain WHITE. If I can, I would like to quote from an earlier sentence in that same letter.

Mr. KENDALL. Go right ahead.

Captain WHITE. I shall start at the beginning:

Several weeks ago, Colonel Cipolla discussed with me the motion difficulties being experienced by Texas tower No. 4. At that time, the basic cause for the exaggerated motion was not definitely known. However, it was suspected that it was probably due to motion of the underwater collars to which the horizontal and diagonal bracing members are attached.

In that context, I was referring to this bracing that had been installed at sea as a part of the repair work that has been discussed.

Mr. KENDALL. You considered that as a part of the original design?

Captain WHITE. The original design of this repaired bracing; yes, sir.

Mr. KENDALL. That was approximately 2½ years after the tower had been turned over to the Air Force for operation?

Captain WHITE. That is right, approximately.

Mr. KENDALL. And you are stating that the motion difficulty was related to the original design?

Captain WHITE. Based on the information that I had, yes, because as I said earlier, the basic cause was not known. However, it was suspected, and on that premise, that was the basis for my statement.

Mr. KENDALL. You did have information about the matter and had had discussions about the tower, had you not?

Captain WHITE. That is correct; yes.

Mr. KENDALL. In the light of what you now know, do you still feel that the tower motion was related to the original design? And I am including the installation of the Dardelet bolts as part of the original design.

Captain WHITE. Well——

Mr. KENDALL. Captain, excuse me. You stated on March 15, 1960, that the motion difficulty appeared to be related to the original design. You just told me that you thought that was a correct statement.

Captain WHITE. That is correct, to the original design of this bracing system that was used in the repairs. Because at the time that I made this statement, I had no knowledge of anything else that could be contributing to this motion.

Mr. KENDALL. We are including that field repair as part of the original design, and you say this difficulty appeared to be related to the original design, did you not?

Captain WHITE. That is correct.

Mr. KENDALL. You stated that that was a correct statement. Now, has anything happened since then to cause you to change your mind?

Captain WHITE. No, I do not believe so.

Mr. KENDALL. So that statement is just as true today as it was in March of 1960, is that right?

Captain WHITE. That is correct.

Mr. KENDALL. But is it not true, Captain, that the motion difficulty at that point in time that you were talking about was not due to the collar movement, but was due to deteriorated pin connections?

Captain WHITE. That could have been, because the information that I had available to me indicated that there was some wear in the pin connections in this top level of bracing here, and over in these pin connections on either side, so that the motion could very definitely have been related to the wear in those pin connections.

DETERIORATION OF PIN CONNECTIONS

Mr. KENDALL. As a matter of fact, your information showed that the pin connections had deteriorated to such an extent that, in some cases, the tolerance was as much as an inch?

Captain WHITE. Oh, generally. I would not like to be pinned down to the last 16th, but in that range, yes.

Mr. KENDALL. So when you were writing this letter as late as March 1960, it would be a true statement to say that the motion difficulty at that time was related to the deteriorated pin connections, rather than to your collar difficulty?

Captain WHITE. That is right.

Mr. KENDALL. Now, Captain, on January 24 of this year, I believe that you held a conference in response to a dispatch from the 26th Air Division relative to an inspection of towers 2 and 3, is that right?

Captain WHITE. That is correct.

Mr. KENDALL. Did you have occasion to pass upon the award of the contract for that inspection?

Captain WHITE. I did.

CONTRACT INSPECTION AND EVALUATION OF TOWERS NO. 2 AND NO. 3 AWARDED TO DESIGN ENGINEERS

Mr. KENDALL. Was that a negotiated contract?

Captain WHITE. It was.

Mr. KENDALL. To whom was it awarded?

Captain WHITE. Moran, Proctor, Mueser & Rutledge.

Mr. KENDALL. Is that the same firm that designed the towers?

Captain WHITE. It is.

EVALUATION CALLS FOR SEAWORTHINESS OF REMAINING TOWERS

Mr. KENDALL. Now, Captain, why would you go back to the same firm that had designed the towers and who had attempted the repairs on tower No. 4 to make an inspection of the structural integrity of the remaining two towers?

Captain WHITE. Well, it seems to me that it was rather basic, that we were given a job by the Air Force to make an investigation to determine the seaworthiness of Texas towers No. 2 and No. 3.

Associated with that job was a matter of extreme urgency, because there was a lot of concern, certainly, following the tragedy of Texas tower No. 4, as to what the condition of the other two towers was.

Now, this concern was shared not only by the people that were on the towers themselves, but by the families of those people. This was a matter of urgency. So it seemed to me that the best people who were in a position to go out on those towers, and specify and determine which parts of the towers should be thoroughly investigated, to determine their structural accuracy, was the firm that originally designed the towers.

Mr. KENDALL. Well, Captain, with all deference to the time element and the urgency of the matter, it appears from the record that the design engineers, time after time, have been consulted, and no one else, about repairs to tower No. 4. Now they are called upon by a new contract to evaluate their own work in towers No. 2 and No. 3.

Now, it is not very likely, is it, that they would admit that there was a design deficiency in towers No. 2 and No. 3 if they found one?

Captain WHITE. I would like to disagree with you just a little bit on one of the premises that you stated; that is, that they have not been called upon to review their original design in no way. What they have been called upon to do is to see whether the towers as constructed meet the requirements that were established by their original design.

Mr. KENDALL. That is not what your memorandum of January 24 says, is it, Captain? Does it not say that the purpose of the investigation was to determine whether towers Nos. 2, 3—and I am quoting here—"were structurally capable of meeting the original design criteria and performing their intended functions?"

Now, certainly that brings into play your whole concept of design, does it not?

Captain WHITE. I am sorry, could I see that?

Mr. KENDALL. Yes.

Senator STENNIS. Off the record.

(Discussion off the record.)

Senator STENNIS. Captain, you are ready to start?

Let us have order, gentlemen.

All right, gentlemen, let us proceed.

Mr. KENDALL. I believe I had a question pending, Mr. Chairman.

Captain WHITE. Yes. I think I am ready to answer the question now.

Mr. KENDALL. All right, sir.

Captain WHITE. It has not been, nor is it now our intention, to have Moran, Proctor go in and review their original design of these towers. Now, the intention of this contract was to satisfy ourselves that the towers as constructed were as they were designed.

Mr. KENDALL. Well, Captain, if you will pardon me, will you explain to me how you can determine whether or not the towers are structurally capable of meeting the original design criteria if you do not take into consideration the design of the towers?

Captain WHITE. I am a little unclear——

Mr. KENDALL. Well, the design is based upon the design criteria?

Captain WHITE. That is correct.

Mr. KENDALL. So if you are going to determine whether or not the structure is capable of meeting the design criteria, you have to examine the design, do you not?

Captain WHITE. As I said earlier, sir——

Mr. KENDALL. That is a simple question; it can be answered yes or no.

Captain WHITE. As I said earlier, sir, it has not been and it is not now our intention to have Moran, Proctor review their original design calculations with respect to the original design criteria.

It is our intent under this contract to have them, and I think it is stated in the contract that the contractor in the shortest reasonable time shall investigate the structural condition of Texas towers Nos. 2, 3 and shall furnish the Government a report thereof.

In doing this, he is to make an examination of all the accessible critical welded connections in the tower structure by means of magnafluxing, radiographic examination, or other means necessary to provide maximum possible evidence or evidence of the presence of defects in or near these connections.

Mr. KENDALL. Captain, may we go back to my question? I asked you how you can determine whether or not the towers are structurally capable of meeting the design criteria, and that is the language of your memorandum, unless you take into consideration the design? You cannot do it, can you?

Captain WHITE. Well, sir, I think we are separating on a point of semantics, really. I tried to tell you what the intent was and what we are going to pay for under this contract, and we are not going to pay for Moran, Proctor to review their original design calculations and determine whether or not that design was capable of satisfying the original design criteria. We are satisfied that that decision was correct.

Mr. KENDALL. Then you are telling us that your memorandum does not mean what it says?

I shall not belabor this point any longer, Captain. Will you make a copy of that memorandum a part of the record? It will speak for itself.

Captain WHITE. I think the services he is actually to provide throughout the body of the memorandum, and those services speak for themselves, as you say.

(The memorandum referred to is as follows:)

JANUARY 20, 1961.

From: 20.
To: Files.
Subject: Evaluation of requirements and determination of scope for inspection of Texas towers 2 and 3.

1. In response to the U.S. Air Force 26th Air Division dispatch 172100Z, a meeting was held at the office of the District Public Works Officer, 1st Naval District on Thursday, January 19, to discuss requirements and determine scope of the requested inspection of Texas towers 2 and 3. The following persons were in attendance:

Dr. P. C. Rutledge, Moran, Proctor, Mueser & Rutledge.
Maj. R. W. Mix, USAF, Otis Air Force Base.
Mr. C. E. Hadrun, 26th Air Force Division Headquarters.
Mr. H. N. Grattan, 26th Air Force Division Headquarters.
Mr. J. J. McConnell, Otis Air Force Base.
Capt. T. J. White, CEC, USN, District Public Works Office, 1ND.
Capt. W. R. Boyer, CEC, USN, District Public Works Office, 1ND.
Mr. R. S. Seddon, District Public Works Office, 1ND.
Mr. R. S. Seddon, District Public Works Office, 1ND.

2. After discussion it was concluded that the following areas should be investigated and evaluated to enable a determination that Texas towers 2 and 3 were structurally capable of meeting the original design criteria and performing their intended functions:

(*a*) Make magnaflux, radiographic or other recognized tests deemed necessary to provide maximum possible evidence of absence or presence of defects at all welds on shear plates and girders at the leg connections; all high stress areas of the girders also, the legs in the critical areas, from the top deck to a point approximately 25 feet below the bottom deck. It was decided also that if the results of these investigations indicated areas or points of fatigue or excess stress, that further such investigations as indicated necessary would be conducted.

(*b*) Inspection for corrosion in the high stress areas of the structure particularly in the underwater portions of the caissons and in the shear plates and girder areas at leg connections also, for the effectiveness of cathodic protection.

(*c*) Underwater inspection for determination of any possible structural damage, scour at the caissons and to investigate and recommend action regarding the sunken fender at TT–2. It was recognized that effective diving operations probably could not be undertaken until late spring or early summer and that such delay on this item would of necessity have to be accepted.

(*d*) The tilted leg on TT–3 was discussed but it was concluded that the results of magnafluxing or other investigation at the connections between this leg and the platform structure would indicate the effects of tilt in the leg involved, upon the structural and stability characteristics of the tower.

(*e*) Re-analyze the stresses in and the safety of these structures under the conditions of wind and wave effects experienced at TT–4 during Hurricane Donna (1960) being encountered at the respective sites. It was concluded that assistance by the Oceanographic Institute at Woods Hole would be required to evaluate all reports of the wind and wave conditions experienced at TT–4 and to extend the results of these evaluations to the maximum wind and wave conditions that should now be considered possible at the locations of TT–2 and TT–3. The Navy (Mr. Seddon) agreed to arrange for this analysis and evaluation and to provide such data to MPMR without cost.

(*f*) If, upon completion of the above analysis, a need for structural strengthening of these towers is indicated, to recommend design modifications or improvements deemed necessary to increase the structural capabilities of the towers.

3. The request for a study to determine the feasibility of installing instrumentation or indicators to forecast structural conditions of the towers was deemed to be a separate matter and accordingly would be handled as such. It was, however, pointed out that previous studies regarding instrumentation for movement and stress measurements had been made and it was generally felt that the reports of these studies could be reviewed, revised or updated as appropriate in the light of recent developments in this area and effective recommendations made.

4. It was discussed and made clear that except for transportation from Otis Air Force Base to the towers, all contacts, negotiations, and other matters regarding this work would be between the A. & E. contractor and the DPWO. Also, it was agreed that all negotiations and administration of the contract for this work would be handled by the DPWO without the need for consultation, reference to further clearance or approval by Air Force representatives. That the point of contact for the DPWO, 1ND with the U.S. Air Force would be with the commander, Otis Air Force Base, and all distribution of information or reports regarding this matter within the Air Force shall be made by the commander, Otis Air Force Base.

5. The urgency and importance of getting inspection work at the site underway was repeatedly stressed. It was therefore recognized that some premium costs probably would be encountered and that such costs in this instance were justified. Due to the many unknown factors involved, a firm estimate of the total probable cost of this work was not available at this time. It was arranged that Dr. Rutledge would submit a proposal to the DPWO and advice as appropriate would in turn be forwarded to the commander, Otis Air Force Base, at the earliest date practicable. In the meantime, it was considered necessary that a preliminary allocation of $25,000 be made available by the Air Force to enable an early and orderly start of this work.

6. Dr. Rutledge was instructed by Captain White to proceed immediately to incur such obligations as were necessary to get the work underway at the earliest date practicable and was assured that a formal letter of intent or notice to proceed would be issued at the earliest date possible. Also, that any obligations incurred to carry out this request would, in the event of cancellation of this work in the meantime, be reimbursed. It was indicated that inspection engineers and magnafluxing equipment was desired at the site at the earliest possible time, preferably on January 23, to which Dr. Rutledge agreed to make every reasonable effort to meet the desire. As requested by Captain White, Dr. Rutledge agreed that he would submit his proposal as quickly as the necessary information, prices, and other matters could be resolved and that in the meantime work would proceed as expeditiously as practicable.

W. R. Boyer.

Copy to: Dr. Rutledge (1), Major Mix (2), BuDocks (2), Code 21 (1).

Mr. Kendall. One final question, Captain. How much money was involved in this contract?

Captain White. It is going to amount to about a total of between $225,000 and $250,000.

Mr. Kendall. Does that include the entire inspection of the towers?

Captain White. That includes everything that we are going to do with respect to this study.

Mr. Kendall. Why does the copy of the contract show only $83,000?

Captain White. For the reason that in order to get this contract started, we had to get authorized the work in increments, because other items of work to be accomplished, such as oceanographic studies, such as underwater scour determinations, such as corrosion surveys—we were not able to get a price on them in such time, nor were we able to sufficiently define the scope of the work that was to be done under these particular things to write them into the contract at the time the original document was drawn. We have since added those items of work by change order.

Mr. Kendall. But you honestly feel that by employing Moran, Proctor, the original design engineers, you are going to receive a completely objective report of the structural stability of towers No. 2 and No. 3?

Captain White. I have no question of it, sir. If I had any question of it, I would not have given them the contract.

Mr. Kendall. I have no further questions.

Captain White. I would like to ask one question. We are clear now, are we not, that the original design that was in my letter to Col-

onel Stephany was the original design as related to the replacement bracing, and did not go to the original design of the complete tower structure?

Mr. KENDALL. Yes, sir; I think we understand that.

Senator STENNIS. Well, Captain, I am not going over what you and counsel have covered. I really have not had a chance to be familiar with this phase of the facts.

As I understand now, you have a contract with these gentlemen for the inspection of towers No. 2 and No. 3?

Captain WHITE. That is correct, sir.

Senator STENNIS. And this contract was executed when?

Captain WHITE. We started working on this——

Senator STENNIS. I mean about when?

Captain WHITE. About the 20th of January, sir.

Senator STENNIS. I beg your pardon?

Captain WHITE. About the 20th of January.

Senator STENNIS. After tower No. 4 collapsed?

Captain WHITE. That is correct.

Senator STENNIS. And that collapse is what caused you to decide to make this exmaination of towers No. 2 and No. 3?

Captain WHITE. This is what caused the Air Force to ask us to make this examination; yes, sir.

Senator STENNIS. Well, I was going to ask you just how you got back into the picture. So the Air Force asked you gentlemen to come into the picture with reference to towers No. 2 and No. 3?

Captain WHITE. That is correct, sir.

Senator STENNIS. And this firm that you employed is the one, as I understand your testimony, that made the original design of towers No. 2 and No. 3?

Captain WHITE. That is correct, sir.

Senator STENNIS. Now, it does appear odd, just being frank about it, that you turned to these gentlemen for the inspection after the experience that you and the Air Force had before. This is no reflection on this company. I do not mean it that way, but it appears odd that you would go back to the same group to evaluate the situation now, which it seems to me necessarily includes the whole design matter. They will have to defend their design or say that it was inadequate, will they not?

Captain WHITE. Sir, I would like to withhold an answer to that question until I get the results of the survey.

Senator STENNIS. Well, I just say, looking down the road to the future, when you go out to employ someone that has already committed themselves to such a major part of this whole inquiry, it is their "child"; they will have to stand by the design or say that it was professionally inadequate, will they not? That is just commonsense, is it not?

Captain WHITE. Certainly I would expect them to stand by their design.

Senator STENNIS. That is right. So when they bring in the verdict on this inspection that you assigned them, they are going to be passing on themselves as far as the design, directly or indirectly, is concerned, are they not?

Captain WHITE. I think that maybe there is confusion in the issues just a little bit, Senator. But what we are asking these people to do is

to determine that the conditions that exist in towers No. 2 and No. 3 are the conditions that were encompassed in their original design.

Now, we have gone a little further than that to the extent that we are making an oceanographic study to determine whether or not the expected conditions now are the same as they were then.

Senator STENNIS. I did not question you, or them either, when I asked the question. I am just getting to basic commonsense, as I see it, in saying that when they bring back their verdict on towers No. 2 and No. 3 under this special contract they, directly or indirectly, to a substantial degree, will be passing on their own design. That is the way it seems to me. How does it look to you?

Captain WHITE. No, sir; we have not asked——

Senator STENNIS. May I ask you to give a reason? You say "No." What are your reasons? Pinpoint your reasons.

Captain WHITE. I do not know whether I can make this clear or not.

Senator STENNIS. Well, do the best you can.

Captain WHITE. We have not asked them, nor are we asking them now, sir, for a statement as to whether or not their original design was capable of meeting the conditions under which that design was prepared. We are not asking for that at all, sir. We are going beyond that and asking: are the towers as they are constructed, and are the conditions of these members, and are the things that exist out there now the same things that you thought would exist at the time that you prepared your design? The results so far have indicated that there are no conditions out there now that were not anticipated in the original design, sir.

Senator STENNIS. So you are not asking them to certify anything about their opinion as to whether those towers are reasonably safe or reasonably adequate or anything like that? If you were, you would certainly be asking them to pass, in part, on their design, would you not? Would not this necessarily follow, if you were asking them if they were safe or if they were adequate?

Captain WHITE. Yes, sir.

Now, a part of this package, of course, is a verification through independent studies as to whether or not the wind and wave conditions which these towers were designed to withstand have changed or not. Now, certainly, the field and the knowledge that has existed in the past, and, to a large extent, still exist with respect to the effect of wind and waves and what might be expected from certain types of storms and what their effect will be on these structures, fixed structures in the open ocean, is extremely limited, sir, and it was limited at the time the towers were originally designed. We would like to augment that information by the information that has been developed by the people who have been on these towers by subsequent studies.

Senator STENNIS. All right, that is a new point. I hope they are able to bring you something worthwhile on that. But if they are not giving you an opinion as to whether or not those towers are adequate and reasonably safe now, I do not see what it is you are paying them the $225,000 for. That is what you want to know, is it not, whether the towers are reasonably adequate or reasonably safe for continued operation You have had this misfortune about No. 4. Now you and the Air Force want to know whether to go on operating these others as I see it.

Captain WHITE. That is correct.

Senator STENNIS. Now, that is a very sound position for you to take, I think. But if you are not paying these $225,000 to $250,000 to these gentlemen to tell you whether or not they are reasonably safe and adequate, I do not see what you are paying them for, except the little point that you mentioned at the last there about the new conditions you might run into.

Captain WHITE. That, in our opinion, sir, is a very important point.

SAFETY OF EXISTING TOWERS IS PARAMOUNT

Senator STENNIS. Well, I do not mean to belittle it, but it is coming pretty high at this figure. It just seems to me that the unanswerable logic of the thing is that you very rightfully want to know about the safety, the reasonable safety and usefulness and practicality of the remaining towers, and that you have employed a firm to inspect them. But as a part of it, the way it looks to me is just the same as though a jury, after having been sent out, should come back and say, "We, the jury, find for the jury." You just do not do things that way.

It seems to me as though you have got to have someone who has not been connected with the design originally to pass on those matters.

Captain WHITE. Senator your analogy may be correct, sir. The only thing I would like to add, sir, is that I was faced with a problem that had to be solved in the shortest time it could be solved in.

After thinking of all the factors that were concerned in this matter, it was my decision to go back to the firm that originally designed these towers and give them this job, because in that way, I thought that the job that I had to do could best be done.

Senator STENNIS. Well, I think your concern is very commendable, sir. I think you and the Air Force both have a special responsibility. However, if you were going to determine the responsibility for the situation as to Texas tower No. 4, you would not have gone to this firm, though, to evaluate it, would you?

Captain WHITE. I was not asked to do that, sir.

Senator STENNIS. I know. But if I were to ask you, or if the committee were to ask you, to recommend someone to determine the situation with respect to Texas tower No. 4, you would not go back to the designing firm to do it, would you? And I speak of the firm with great deference; it is one of our best ones.

Captain WHITE. I would rather defer an answer to that, Senator.

Senator STENNIS. All right, I do not want to press you. But I think the fact that you want to defer it shows that you would not turn to them, and your better judgment would lead you away from them.

If you would rather not answer it, that is all right.

Anything else, gentlemen?

Mr. KENDALL. I have no further questions.

Senator STENNIS. I want to thank you again, Captain, for being with us and bringing us these facts. If you will remain with us during the day, please, I would appreciate it.

Captain WHITE. Sir, I am here at your pleasure.

Senator STENNIS. Gentlemen, shall we proceed?

It is now 12:20. Do you have another witness?

Mr. KENDALL. We have another witness that will take us about 45 minutes.

Senator STENNIS. Well, let us proceed, and see if we can get through by about 1 o'clock.

TESTIMONY OF ALAN D. CROCKETT, MARINE CONTRACTORS, INC., EAST BOSTON, MASS.

Senator STENNIS. Mr. Crockett, you were one of the gentlemen who were sworn this morning?

Mr. CROCKETT. Yes, sir.

Senator STENNIS. Mr. Kendall, I think that you can identify Mr. Crockett for the record and get his background.

Mr. KENDALL. I believe your name is Alan Crocket, is that correct?

Mr. CROCKETT. Yes, sir.

Mr. KENDALL. Where are you from?

Mr. CROCKETT. I am from Boston, Mass., associated with Marine Contractors Co., Inc., as general manager. I have been there for 4 years.

Mr. KENDALL. Will you state for the record your background, including your educational attainment and your business?

Mr. CROCKETT. Professionally I am a mechanical engineer, so licensed in the State of Maine; class of 1944, University of Maine, mechanical engineering.

I am qualified in the Federal courts in Massachusetts as a surveyor, predominantly marine, however.

Mr. KENDALL. I did not hear that last statement.

Mr. CROCKETT. I am qualified in the Federal courts of Massachusetts as a marine surveyor, and am on consulting boards of Thomas Walsh, a firm of attorneys in Boston, and Sanger & Sanger, admiralty attorneys in Boston.

Mr. KENDALL. You are presently connected with the Marine Contractors?

Mr. CROCKETT. That is correct.

Mr. KENDALL. What type of business are they engaged in?

Mr. CROCKETT. We are specifically a marine repair concern. We deal with marine surveys, actual repair operations, underwater surveys of most any nature.

Senator STENNIS. Mr. Crockett, you do not have a prepared statement?

Mr. CROCKETT. No, Mr. Chairman, I do not, with the exception that I would like to make it clear for the record that I, as an engineer, or my company, have never been considered in any of the design problems or the original design of any of the towers, nor have we been consulted with this in mind.

Senator STENNIS. All right.

Mr. CROCKETT. Our work has been predominantly observations of existing conditions.

Senator STENNIS. All right, thank you, sir.

Mr. KENDALL. Mr. Crockett, you are here in obedience to a subpena issued by the committee, are you not?

Mr. CROCKETT. Yes, sir.

Mr. KENDALL. You were subpenaed because we were advised that your company from time to time made certain underwater surveys or inspections of Texas tower No. 4; is that correct?

Mr. CROCKETT. This is correct.

Mr. KENDALL. When was the first survey you made?

UNDERWATER SURVEYS OF TOWER NO. 4 BY MARINE CONTRACTORS, INC.

Mr. CROCKETT. November 25, 1958, was the date of issue of the actual report. The survey was conducted just prior to that.

Mr. KENDALL. Will you briefly explain to us the significance of your findings, insofar as they pertained to the structural stability of tower No. 4?

Mr. CROCKETT. The survey was to consider the inspection of all underwater connections and bracings on caissons A, B, and C at the minus-20-foot level; the examination of the collars on A and B caissons at the minus-65–70-foot level; also to inspect both collars on each side in the way of the Dardelet bolts.

The second phase was to tighten 36 holding bolts on caissons A and B collars at the minus-65-foot level to a torque of 1,300 foot-pounds; also to assist in locating an oil leak in the A caisson.

We did this survey and it is a matter of record—I can read it to you, if you so desire.

Mr. KENDALL. I would like you to explain it as best you can so that we can understand it, and submit a copy for the record if you will, please, sir.

Mr. CROCKETT. Will do.

The bracings, all bracings, caissons, and underwater parts of the tower foundation were found to be heavily coated with marine growth. The growth appeared much denser in the zero to minus-20- or 25-foot level, ending completely at minus 90 feet. All underwater parts were found to be very well protected from use of the cathodic protection. Their appearance was black in color, with fine scales of about 20 mils.

At the minus-23-foot level——

Mr. KENDALL. Excuse me, Mr. Crockett. Can you give us a synopsis of the significant findings affecting the stability of the tower or the collar connection there?

Mr. CROCKETT. Yes, sir.

We found at this time, on cleaning of the collar connection, that the B caisson collar had no vertical motion.

Mr. KENDALL. Can you point it out on the model as you go along? As you do, indicate which sides are A, B, and C.

Mr. CROCKETT. This one [indicating] is A, this one is B; this other one is C. The collar at B was found to be without vertical motion; all bolts, nuts, and double nuts were found to be in place. However, the Dardelet keeper plates were loose and several of the studs and nuts were missing from these plates. The plates were three-eighths of an inch thick steel plate installed over the heads of the Dardelet bolts to endeavor to keep them in position. This plate was installed with eight half-inch studs welded to the caisson. The plates were installed in the field and do not show on any construction print. The collar holding bolts were found to be at an average of 900 foot-pounds

torque. These bolts were torqued to 1,300 foot-pounds. They were found to be holding at 1,300 foot-pounds after slight sea conditions—that is, on checking at a later date, a day or two later, after we had encountered slight sea conditions.

Mr. KENDALL. At that time, Mr. Crockett, was any consideration or particular attention given to a possible deterioration in the pin connections, particularly on the A B side of the tower?

Mr. CROCKETT. We examined all the pin connections at the minus-23-foot level and found that they were reasonably within their tolerance.

In order to ascertain whether a pin was exactly within its tolerance, it would have to be opened up; that is to say, the locking devices on the extremities of the pin would have to be removed to determine the clearance between the pin diameter and the diameter of the hole. This was not done.

However, we could ascertain very slight motion, which was, say, possibly an eighth of an inch in clearance, which we felt at that time was within the design tolerance.

Mr. KENDALL. This is a survey that was made approximately 1 year after the tower was in operation?

Mr. CROCKETT. That is so.

Mr. KENDALL. What did you find with reference to the collar connections secured by the Dardelet bolts?

Before you answer that, let me ask you, Mr. Crockett, are Dardelet bolts ordinarily used for a permanent fix or a temporary fix?

Mr. CROCKETT. It could be used, I suppose, as a permanent fix. However, it has been my small experience in the past to use them temporarily.

Mr. KENDALL. Now, will you go ahead and tell us what you found with reference to the collar connection and the Dardelet bolts?

COLLAR CONNECTIONS IN VERTICAL MOTION ON LEG

Mr. CROCKETT. The A caisson collar at the minus-65- to 70-foot level was cleaned of marine growth over its entire connection area. We found the caisson in the way of the top and bottom edges of the collar shined to bright bare metal. This bright metal, approximately 2 inches in width, was caused by vertical motion in the collar.

Upon further investigation, we found that several of the jam nuts and double nuts that secured the 2-inch collar hold bolts had slackened away from the holding nut an inch or two.

Mr. KENDALL. So you found that collar was sliding up and down on the caisson?

Mr. CROCKETT. Yes, sir.

Mr. KENDALL. And that the bolts themselves had slacked to how much? Two inches?

Mr. CROCKETT. Some of them were off in fixture as much as 1 to 2 inches. This was not the case in all the bolts. However, we found that the collar bolts have very slight, if any, torque when we endeavored to torque the connection.

Mr. KENDALL. Then did you conclude from that that the fix that involved the collar connection was not holding?

Mr. CROCKETT. Say that again, please.

Mr. KENDALL. The repair work, involving the installation of the collar, was not holding, as I understand it.

Mr. CROCKETT. Not at that particular time. We also found that the Dardelet keeper plate that we had found on B caisson was missing on A caisson.

Mr. KENDALL. What is the keeper plate?

Mr. CROCKETT. The keeper plate was a field installation, I am given to understand, to hold the Dardelet bolts in place, obviously. It was a steel plate some three-eighths of an inch thick covering the entire area, the Dardelet area, secured by half-inch bolts to the caisson. Why this was installed? I have never seen it on any drawing and I do not believe there is any specific note in the design of this. I believe it was a field installation.

Mr. KENDALL. Were the collars on both the A and B legs moving vertically on the leg?

Mr. CROCKETT. The B caisson collar was found to be firm, without motion. The A caisson collar was found to be in vertical motion.

Senator STENNIS. May I interrupt there? Was it in this Dardelet bolt connection and collar that you found this 1 inch or more play?

Mr. CROCKETT. It had to be through that section, sir. This collar on A attached to the A caisson here [indicating] had vertical motion as much as an inch on each side. That would make a motion of about 2 inches.

Senator STENNIS. The brace where it fastened?

Mr. CROCKETT. The whole collar structure.

Senator STENNIS. The brace is attached to the collar?

Mr. CROCKETT. Yes.

Senator STENNIS. So it had a motion of an inch up and an inch down, to make a total of 2 inches?

Mr. CROCKETT. Yes, sir.

Some of these Dardelet bolts were found to be missing at this time. This was also at the time we found the Dardelet bolts were of not true size according to specifications. Normally, in a thing of this nature, we examine the specifications prior to a survey, and we found that the holes were oversize and that the Dardelet connection had not been installed according to the drawing. This was a matter of record.

Mr. KENDALL. This brace you are talking about was on the AB side at the minus 25-foot level?

Mr. CROCKETT. This brace I am talking about was right there [indicating] on the A caisson at the minus 75-foot level. The motion appears at the top and bottom.

Mr. KENDALL. Well, did that indicate that that brace was not functioning properly?

Mr. CROCKETT. It was functioning, but not properly. It was still intact and still holding, but it did have motion in it adverse to the design. The design was to have it firm. This is why we were there, to endeavor to draw this firm.

Mr. KENDALL. What was done as a result of your inspection or your report?

Mr. CROCKETT. We torqued the collar holding bolts on both sides up to 1,300 foot-pounds, and in so doing, we stilled the vertical motion such that at the time we left this connection, it was firm. However, at this time, we did not deal with the Dardelet bolts.

Mr. KENDALL. This was before the T-bolts were installed, I believe?

Mr. CROCKETT. Yes, sir; this finding was the generating factor that dreamed up the T-bolts.

Mr. KENDALL. It was after your report, your examination, that the decision was made to install the T-bolts?

Mr. CROCKETT. Yes, sir.

Mr. KENDALL. Now, at the time of your first examination there, how closely did the collar conform to the caisson?

Mr. CROCKETT. In part, very well. However, at the point of connection between the diagonal and horizontal bracing, it did not conform to within three-quarters to an inch of space.

Mr. KENDALL. Three-quarters to 1 inch in space?

Mr. CROCKETT. Right.

This was the object in endeavoring to torque the bolts to 1,300 foot-pounds. Even after we got to 1,300 foot-pounds in torque, we could not make the collar conform 100 percent. However, we brought it up tight enough so that it had not vertical motion.

Mr. KENDALL. Now, when did you make the next inspection of the tower?

Mr. CROCKETT. As a result of this particular survey, a T-bolt connection was put into effect, and we were given an inspection contract to inspect the repair done by J. Rich Steers of New York. It was June 26, 1959, that our report was submitted.

Mr. KENDALL. Mr. Crockett, will you make that a part of the record, and also your report of November 25, 1958?

Mr. CROCKETT. I will, sir.

(The documents referred to are as follows:)

NOVEMBER 25, 1958.

Subject: Contract No. NBY22027 Texas Tower No. 4.

OFFICER IN CHARGE OF CONSTRUCTION,
Texas Towers, District Public Works Department,
First Naval District, Boston, Mass.

(Attention: Mr. Joseph Riccio).

DEAR SIR: As directed in your contract, we are submitting a survey report, the conditions of underwater parts of Texas tower No. 4, and the repairs accomplished during the time of the survey. The contract was divided into three specific parts:

I. The survey and inspection of all underwater connections and bracings on caissons A, B, and C at the minus-23-foot level, and the examination of the collars on A and B caissons at the minus-65-foot level. Also to inspect both collars on each side in the way of the Dardelet bolts.

II. To tighten 36 holding bolts on caisson A and B at the minus-65-level to 1,300-foot-pounds torque.

III. To assist in locating an oil leak in caisson A.

Under item one, the examination and survey produced the following findings:

All bracings, caissons, and underwater parts of the tower foundation were found to be heavily coated with marine growth. The growth appeared much denser in the minus zero to 20 or 25 foot level, ending completely at minus 90 feet. All underwater parts were found very, very well protected from use of the cathodic protection. Their appearance was black in color and a fine scale of about 20 mils was apparent.

At the minus-23-foot level all horizontal spans, pins, and locking devices were cleaned at their connection points. All horizontal spans were found intact. The pin at the center connection in the diagonal brace on A caisson to the horizontal span between A and B caissons was to be found to be loose; that is, the pin was in position with all its keepers intact. However, the diagonal brace did not seem to be bearing on the pin. The pin in the horizontal span between A and B caisson at the B caisson connection was found to be withdrawn approxi-

mately 9 inches; its locking devices and keeper pin missing. All other pins, connections, and bracings were found to be in excellent condition at the minus-23-foot level.

During the repairs, a temporary locking device was fabricated and was installed to insure the pin's staying in its present position. The pin, although withdrawn 9 inches, was still in shear with all parts of the connection.

B caisson collar at the minus-65-foot level was cleared of marine growth. The collar was found to be without vertical motion; all bolts, nuts, and double nuts were found to be in place. However, the Dardelet keeper plates were loose and several of the studs and nuts were missing in the keeper plates. A rectangular plate three-eighths of an inch thick was installed over the heads of the Dardelet bolts to stay in position. The plate is secured to the caisson by means of eight ½-inch studs welded to the caisson. This plate was installed in the field and does not show on any construction print. The collar holding bolts were found to be at an average of 900-foot-pounds torque. These bolts were torqued to 1,300 foot-pounds. They were found to be holding at 1,300 foot-pounds after slight sea conditions.

As well as could be ascertained without removing the keeper plates of the Dardelet bolts, we found that several of them were loose at the upper and lower extremities of the collar.

On further examination of B caisson, we found two double sheave blocks and 70 feet of wire cable hanging from shackles at the minus-70-foot level. These blocks were removed and salvaged, the cable dropped. This removal was made at the request of the naval inspector, Mr. Kelleher.

A caisson collar at the minus-65-foot level was cleaned of marine growth over its entire connection area. We found the caisson in the way of the top and bottom edges of the collar shined to bright bare metal. This bright area, approximately two inches in width, was caused by vertical motion in the collar. Upon further examination, we found that several of the jam nuts and double nuts that secured the 2-inch collar hold bolts had slackened away from the holding nut an inch or two. It was also found that the Dardelet bolt keeper plates were missing.

None of the Dardelet bolts on either side were in place, having either fallen out or sheared off. We found six Dardelet bolt shanks still in the caisson. The bolt holes had the appearance that the bolts had been sheared by the vertical motion of the collar; that is, the holes had a top and bottom elongation rather than a true round hole. Each of the holes with the elongation seemed to have been radiused on the extreme edges, indicating that the bolts had finally sheared after considerale vertical motion.

Concerning the collar holding bolts and nuts, it was found that several of the nuts were hand tight. Our first operation endeavoring to torque the bolts to 1,300 foot-pounds gave us no indication of torque on any of the bolts. However, we were using a 2,000-pound meter on an extremely large wrench such that there may have been slight torgue on some of the bolts not indicated by the heavy wrench. We tightened all bolts with a hand wrench and then torqued to 1,300 foot-pounds.

Over a period of 1 night, we found on examination the following day that the bolts were again out of torque. We had found on close examination at the top and bottom edges of the collar that the collar was not conforming 100 percent to the caisson. Consequently, when the bolts were torqued to 1,300 foot-pounds, the collar was drawn closer to the caisson so that our 1,300 foot-pounds was not true. The reason being the collar could not be drawn to full friction with the caisson in one operation of tightening. Through the night with the working of the collar and bracing, the collar would further conform to the caisson. We then torqued the holding bolts up to an average of 1,800 foot-pounds endeavoring to draw the collar into friction in one operation.

This was successful in stopping the vertical motion. However, the torque over a period of 2 standby days was reduced to 1,300 foot-pounds. We again torqued to an average of 1,800 foot-pounds and in this operation we were successful in holding the bolts at a constant torque. The collar at this time was bearing in friction approximately 80 percent.

We checked the pin at the extremity of the diagonal brace from the minus-65-foot level on A caisson to the center of the minus-23-foot horizontal span from A to B caisson; this is the pin that was found to be out of shear and loose in the initial survey. At this time, this pin was in full shear. The jamming nuts were brought to bear for the last time during this repair period.

We were requested by Mr. Kelleher to further examine A caisson to determine whether or not any of the construction blocks and cable were present. This request was carried out, and we found two double sheave blocks on A caisson in the same position as had been previously found on B caisson. These were cleaned, rigged, removed, and salvaged. These four blocks that had been salvaged were thoroughly cleaned and used as an example of the cathodic protection substantiating the previous opinion that the protection was very effective.

Re item III: The third item in the contract stated that we were obligated to assist in the locating of an oil leak in A caisson. We made several exploratory dives from zero to minus 165 feet and did not locate a leak. During these periods, a fluorescent dye was mixed into the oil in A caisson. The quantity of oil in A caisson was increased to insure a greater depth of oil and to increase the head pressure. After such time as the dye had thoroughly mixed in the oil, we made further exploratory dives.

The leak was indicated by the brillant oil slick at the surface of the water. We found the oil leak at the minus-63-foot level of A caisson. The hole was approximately 7 inches above the top of the collar and 8 to 9 inches to the left of the top Dardelet bolt hole on the outside of A caisson. It had the appearance of being a burned hole larger on the outside than it was on the inside, approximately one-half inch in diameter and in the area of the internal concrete plug. We drilled, reamed, and tapped to insert a ½-inch pipe plug. After this operation was completed, the oil slick at the surface stopped and we saw no evidence of any other leak.

However, on gaging the oil ullages, we found a 4-inch loss of liquid in 24 hours. This developed that there had to be another leak. At this time there was no apparent oil slick. We further increased the volume of oil in A caisson and there developed another oil slick.

This slick covered a greater area than the previous slick. We investigated, and found the leak to be within the bounds of a 2-foot-square area in the upper section of A caisson collar between the collar holding bolts and the upper Dardelet bolts.

A portion of the oil was leaking out of the top left-hand Dardelet hole; the remainder upward between the collar and the caisson. We drove a wooden plug into the upper left Dardelet hole endeavoring to further determine whether the leak could possibly be in the area directly behind the Dardelet holes or leaking to the left of the Dardelet holes with such force so as to tunnel a path in the marine growth between the collar and the caisson at the upper left Dardelet hole. Upon the insertion of the plug, we appreciated a slight leak in the upper center and the right Dardelet hole. However, the upward volume was greater increased. Weather conditions permitted no further investigation at this time.

The weather conditions did not give sufficient light for photographic definition; that is, of the 70 exposures developed, we did not have distinction or light sufficient to use the photographs to substantiate the survey.

We examined C caisson in its entirety and found all solid connections to be intact and in excellent condition. We examined the horizontal bracing at the minus-77-foot level and also at the minus-135-foot level and found all to be in excellent condition.

Respectfully submitted.

A. D. CROCKETT.

NOTE.—For the record, we installed a rubber expanding pipe plug in the outlet of the air operated valve at the minus-140-foot level on A caisson. This plug was installed to insure no water loss in A caisson while we were endeavoring to determine the whereabouts of the oil leak.

MARINE CONTRACTORS CO., INC.,
East Boston, Mass., June 26, 1959.

RESIDENT OFFICER IN CHARGE OF CONSTRUCTION,
Texas Towers, First Naval District Public Public Works Department, Boston, Mass.

DEAR SIR: As instructed in our present inspection contract N.B.Y. 27190, we are pleased to submit the following summarization.

The period of inspection May 22, 1959, to June 13, 1959, excluding May 26th to June 3d, Marine Contractors' divers watched the procedures and progress of Stears M.K. divers installing the Hi Tensile T-bolt connection on caissons A and B Texas tower 4.

All work performed by the installing divers was accomplished in a good workmanlike manner, and in accordance with standards set up by the contracting officer.

The T-bolt connection was completely installed and all nuts were torqued to 1,300 ft.-pounds. The collar-holding bolts were torqued to 1,600 pounds. The installation is complete on caissons A and B.

The T-bolt connection tended to conform the collar to the caissons in a very satisfactory manner. However the vertical motion of the collar and cross brace is now reduced to zero.

Considerable increase in the marine growth was noticeable since the dates of last observations in September 1958.

Submitted with this report are three sets of pictures taken of the operation and are self-explanatory.

Yours very truly,

MARINE CONTRACTORS CO., INC.,
ALAN D. CROCKETT.

Mr. KENDALL. Go ahead, sir.

Mr. CROCKETT. This particular phase of construction and repair was done in a good workmanlike manner, as so stated here:

All work performed by the installing divers was accomplished in a good workmanlike manner, and in accordance with standards set up by the contracting officer.

The T-bolt connection was completely installed and all nuts were torqued to 1,300 foot-pounds. The collar-holding bolts were torqued to 1,600 pounds. The installation is complete on Caissons A and B.

Mr. KENDALL. At that time, was any consideration given to a possible deterioration in the pin connections?

Mr. CROCKETT. I think not, sir. However, we did find in the original survey that the pin at the connection of the diagonal brace from B caisson to the horizontal brace between A and B caissons at the minus 25-foot level was found to be slightly withdrawn. It had lost its taper pin and holding collar.

Mr. KENDALL. This is not an increase in the tolerance, but a withdrawing of the pin?

Mr. CROCKETT. A withdrawing of the pin.

Mr. KENDALL. This was at the time of your original inspection?

Mr. CROCKETT. Yes, sir.

Mr. KENDALL. On your subsequent inspection, was that limited to making a determination of whether or not Steers had properly formed the repair work?

Mr. CROCKETT. At the time of June 26, 1959, when we inspected the repair, the pin had been withdrawn and replaced, and new keepers installed. It was then intact.

Mr. KENDALL. Did you find anything of significance structurally wrong with the tower at that time?

INSPECTION REVEALED NOTHING STRUCTURALLY WRONG AT THIS TIME

Mr. CROCKETT. I would say not. We did not find anything structurally wrong at that particular time.

Mr. KENDALL. Did you thereafter make another underwater survey, and if so, when?

Mr. CROCKETT. I did. I made a survey. The report is dated February 16, 1960.

Mr. KENDALL. What was the purpose of that?

Mr. CROCKETT. The procurement officer from the Air Force base, representing the Air Force at the particular tower, requested that we do an emergency examination because of erratic motions, oscillations, that the tower had generated, and also peculiar noises throughout A caisson.

Mr. KENDALL. In other words, you were employed by the Air Force on this occasion because they experienced excessive motion, and were also hearing noises under water; is that correct?

Mr. CROCKETT. That is correct.

Mr. KENDALL. You made the underwater survey?

Mr. CROCKETT. Yes, sir.

Mr. KENDALL. What was the significance of your findings?

Mr. CROCKETT. We found at this time, in examination of all the brackets and pin structure connections, that we had an aggravated wear from being within tolerance at the minus 23-foot level, and progressing to an inch and an inch and one-eighth.

This measurement of an inch or an inch and one-eighth is taken by motion in the pin, an external motion in the pin, rather than a measurement between the pin diameter and the keeper plate diameter, the hole diameter. Consequently, it could be plus or minus one-sixteenth, something like this.

Mr. KENDALL. This is at the minus 23-foot level you are talking about?

Mr. CROCKETT. Yes.

Mr. KENDALL. Was that on all planes?

Mr. CROCKETT. Reasonably. Through the AB section, we found a greater amount of wear. I would have to refer to the record to distinguish one pin from the other.

Mr. KENDALL. What was the condition of the pins in the lower braces, that is, in the remaining portions of the tower?

Mr. CROCKETT. This lower panel [indicating], we found the pins were in their original tolerance. There appeared to be no motion whatever to them. As we increased to the minus 75-foot level, we found that they had slight wear; at the minus 25-foot level they had almost double that wear. We found a half-inch to five-eighths of an inch on the 75-foot panel, and as I say, an inch to an inch and one-eighth in the minus 25-foot panel.

Mr. KENDALL. What about the lower panel?

Mr. CROCKETT. That appeared to be stable in its tolerance.

Mr. KENDALL. The greater wear was in the top level of bracing?

Mr. CROCKETT. Yes, sir.

Mr. KENDALL. And the wear diminished as the braces went lower?

Mr. CROCKETT. Yes, sir.

Mr. KENDALL. What did that indicate?

Mr. CROCKETT. It would appear from the motion of the tower that the excessive motion was creating an excessive wear. This wear was generated over a period of some 14 or 15 months from being within tolerance up to and inclusive of an inch to an inch and one-eighth.

Mr. KENDALL. Would you say that was substantial deterioration?

Mr. CROCKETT. I most certainly would.

Mr. KENDALL. In addition to that, what else did you find on that survey?

Senator STENNIS. Just a minute, Mr. Crockett. Before you go into that, we can hear you all right here, Mr. Crockett, but the press has a special responsibility. They are interested in your testimony and they are sitting behind you, and do not have the advantage we have.

Could you move those two microphones in to give you a little more freedom in shifting your position, and then try to stay a little closer within reach of one or another?

Mr. CROCKETT. I feel like an orphan up here, Mr. Chairman. My cohorts had substantial company.

Senator STENNIS. You are doing all right. Just proceed.

Mr. KENDALL. I believe I had a question pending; did I not?

Mr. CROCKETT. Yes, you did, sir, and I would like just 1 minute to consider the record.

Predominantly, that was the total of the finding. We made a statement as to the oscillatory motion and directions, that it seemed to terminate very abruptly in a northerly direction.

Mr. KENDALL. Was any repair work generated as a result of this survey, Mr. Crockett?

Mr. CROCKETT. Yes, sir.

Mr. KENDALL. What was it?

INSTALLATION OF X-BRACING ABOVE WATER CONSIDERED

Mr. CROCKETT. Upon several consultations after this survey was tendered, it was decided by the powers that be to install this so-called X-ray bracing up here.

Mr. KENDALL. That is shown in red on the model?

Mr. CROCKETT. Yes, sir.

Mr. KENDALL. That is above water?

Mr. CROCKETT. Yes, sir.

Mr. KENDALL. The X-bracing?

Mr. CROCKETT. Yes, sir.

Mr. KENDALL. Now, prior to the installation of that above-water X-bracing, did you have any discussion about it with Mr. Theodore Kuss?

Mr. CROCKETT. Mr. Kuss was present at the meeting at Otis Air Force Base at the time the total wear was considered in the pin bracing, and at the outset of the consideration of the X-ray bracing.

It was his statement that this had been previously designed, but no specifications written for it, and he felt that this could be put into effect immediately.

Mr. KENDALL. Well, did you then have any opinion about the possible efficacy of that X-bracing without the repairs of the brace at the minus-75-foot level?

Mr. CROCKETT. The opinions I had at the time were strictly personal. I was not paid for any consultation as to whether I felt this or I felt that.

My personal opinion was that a repair should have been made from the lowest defective connection up to and inclusive of the minus-

25-foot level prior to any other repair. This is my own personal opinion.

Mr. KENDALL. Did you express that opinion to anyone at that time?

Mr. CROCKETT. I did, before that meeting.

Mr. KENDALL. Was Mr. Kuss there at the time?

Mr. CROCKETT. Mr. Kuss was there.

Mr. KENDALL. What was Mr. Kuss' reaction?

Mr. CROCKETT. Mr. Kuss was in favor of the X-ray bracing.

Mr. KENDALL. Without repairs at the minus-25-foot level?

Mr. CROCKETT. He felt repairs should be made at the minus-25-foot level, but I feel that he felt that the X-ray bracing would seriously enhance the stability of the tower. Thus he deemed it advisable to go ahead with the X-ray bracing first.

Mr. KENDALL. Was not installation of that X-bracing contrary to the original concept of the design of the tower?

Mr. CROCKETT. I believe that it was.

Mr. KENDALL. In case I have not asked you, Mr. Crockett, would you make a copy of that report of February 15, 1960, a part of the record?

Mr. CROCKETT. Yes, sir.

(The document referred to is as follows:)

FEBRUARY 15, 1960.

BASE PROCUREMENT OFFICE,
Otis Air Force Base, Mass.

Reference contract No. (19–603)60–4520.

To nonpersonal services to furnish all plant, labor, equipment and materials. and accomplish all operations required for the emergency inspection of underwater structural bracing Texas tower No. 4. In accordance with technical provisions and general clause.

In accordance with the terms of general clause and technical specifications of the above-cited contract, we respectfully submit the following report.

Inspection performed, February 8, 1960.

Weather conditions severe: Wind 25 to 30 knots. Seas 15 to 20 feet height. Cloudy.

Three divers down to complete survey of bottom and entire length of each caisson including the structural bracing.

BOTTOM

Bottom of caissons A, B, C, were found to have a buildup of sand around the caisson footing approximately 6 feet in height. The bottom area around the tower contains considerable debris; namely, 50-gallon drums, construction steel, wire cable rope, blocks, hoses, etc. C caisson had an abandoned diving platform against the footing. However, none of this debris is doing damage to the caissons.

CAISSONS A, B, AND C

The caissons were surveyed from the surface to the bottom minus 185 feet. Each caisson was found heavily coated with marine growth and mussel beds to a depth of minus 90 feet. No obstructions, cables, blocks, wire, or blocks were found on the surface of B or C caissons. A caisson had a rope hawser around the caisson at the minus-25-foot level and had considerable wire rope below 100 feet minus. We found no hanging or loose articles attached on any of the caissons that could account for any of the reported noises heard on the tower. The

collars on A and B caissons were carefully scrutinized and proved to be within motion. All of the portable connection bolts were in place. The high-tensile connection bolts were secure and appeared to be tight. We did not check these bolts for torque. The collar holding bolts were in place, but several were observed to be loosened. The welded diagonal strut attached to the collars was intact and no fractures noted. The sea suctions and discharge connections in the caissons were found to be heavily coated with marine growth.

HORIZONTAL BRACING OF SPANS, DIAGONAL STRUCTURES

The horizontal bracing at minus 125 feet was found intact, all pins were in place, and all keepers secured. The clearance around the pins was felt to be within original tolerance of one-eighth inch, plus or minus. No fractures were noted in any of the welded sections. The diagonal struts pinned at each caisson and rising to the center of the horizontal spans at minus 75 feet were in place and all caisson pins appeared to have no increase in tolerances. The pins at the upper end at minus-75-foot level had clearance of approximately one-half inch. This play was consistent throughout these particular connections at this level.

The horizontal spans at minus 75 feet had clearance at the pinned connections at their extremities. The play was found to be greatest in the A and B sections. The span between A and B caisson at the minus-75-foot level at the B caisson connection has approximately 1 inch of clearance. The clearance at the A caisson connection was approximately one-half inch. The diagonal struts rising from this level to the minus-25-foot level were in very slight motion at the lower connection but had approximately 1 inch of clearance and in motion at the connection to the minus-25-foot span between A and B caissons. The pins at the extremities of this span have 1-inch clearance at the A and B caissons connection. The triangular bracing between the horizontal spans was found to be in place at all three levels. All welded sections were without noticeable fractures. However, not to be found on the construction drawing were bolts in the connection flanges at each horizontal span. All bolts were in place and appeared to be tight. The welded connections at all three levels on A, B, and C caissons appeared to be in good condition and no fractures were noted in these areas. At the connection of the horizontal span at minus-25-foot level the 4-inch pipe slip joint was found to be fractured. However, there seemed no danger of any part of the section being carried away at this time.

SUMMARY

This concern did a similar survey on tower No. 4 last October 1959 [sic 1958] and the results did not show the magnitude of clearance to be found in the pins that we have appreciated during this survey. We feel that there is approximately three-quarters inch increase in clearance between the surveys. It should be noted that the above survey was superficial in that we did not remove any of the flanged keepers on the pin extremities, thereby could not determine whether the pins or the flanges were receiving the greatest wear.

The tower movement is very erratic in an oscillatory direction. The extreme motion seems to predominate in a northerly direction and slightly in a westerly direction. This motion terminates very abruptly in the northerly direction and at times has reverberations at this extremity before recovering to normal.

The noise factor heard on the tower in the vicinity of a caisson is resulting from the motion of the tower taking up total clearance in the pins and flanges on one side or the other to bringing the two metal surfaces together at the extremity of motion causing the metallic bang.

PLAN REFERENCE

Texas TT–4 bracing details, 678262.

Texas TT–4 replacement braces, 780310.

To be found marked in accordance with this survey at base installation office in care of Lt. F. Weaver.

Respectfully submitted.

A. DAVID CROCKETT.

Mr. KENDALL. I believe, Mr. Crockett, after the tower collapsed, you were called by the Air Force to provide diving and possible rescue work in connection with the tower; is that correct?

Mr. CROCKETT. That is correct, sir.

Mr. KENNEDY. Would you briefly describe your activities in that connection and give the subcommittee a description of the wreckage location and caisson footings and footing integrity, and so forth?

Senator STENNIS. Just a minute, Mr. Counsel. This is something, now, after the collapse of the tower. Does this testimony involve in a substantial way anything concerning the officers that we mentioned this morning?

Mr. KENDALL. No, sir.

Senator STENNIS. It will not. All right, Mr. Crockett; proceed.

POSSIBILITY OF SURVIVORS TRAPPED IN PLATFORM

Mr. CROCKETT. In short, we were called—in fact, at the very outset of the tower collapse, there was a feeling on the part of some of us that there possibly was some life still on the tower, even though it had been submerged. There have been many cases in the past of people living in submerged objects for some little time. We felt there was—it was worth the risks involved to go out and endeavor to get into the tower to ascertain whether or not there was any life there.

This we did, and found there was no life, and I personally do not believe there had ever been any life from the time the tower collapsed.

In fact, we know from further searching operations into all the compartments of the tower in its present position, and we found one body. The body was recovered, and I assume delivered to the proper place.

SURVEY AND DESCRIPTION OF TOWER WRECKAGE

At this particular time, we were requested to make a survey of the conditions of the tower as they existed, with its relative position to its original position.

Mr. KENDALL. Will you tell us what you found on that?

Mr. CROCKETT. This we did. We found the tower wreck to be some 200 yards, at a bearing of 245° from its original site. The AB side bears at 355°, whereas the original AB plane on the original site was just a few minutes short of 30°.

Mr. KENDALL. Did you prepare any drawings or sketches of the position of the wrecked tower on the ocean floor?

Mr. CROCKETT. Yes, I did, sir.

Mr. KENDALL. Do you have those with you?

Mr. CROCKETT. Yes, I do, sir.

Mr. KENDALL. Will you submit them for the record, please, sir?

Mr. CROCKETT. Yes, sir.

(NOTE.—These two sketches of tower wreckage will be found on pp. 33 and 34 of the subcommittee report.)

Mr. KENDALL. Did you make an examination of the footings of the tower?

Mr. CROCKETT. We did; however, somewhat superficially.

Mr. KENDALL. What do you find in that connection?

Mr. CROCKETT. We found that two were fractured and that one had been bent.

Mr. KENDALL. Are you talking about footings now, or the caissons?

Mr. CROCKETT. I am talking about the caisson attachment at the footing. The B caisson bent just above its footing.

I might say we found all three footings to be intact. We did not see or find any distortion that was evident at the time, nor do we feel that they were cocked out of a perpendicular plane with the ocean floor.

Mr. KENDALL. You say you did not feel they were?

Mr. CROCKETT. We did not.

Mr. KENDALL. In other words, you found them to be structurally sound at that time?

Mr. CROCKETT. We did.

Mr. KENDALL. As far as you could determine.

Go ahead.

Mr. CROCKETT. We found the B caisson to be bent. We found the A and C caissons to be fractured. All three caisson sections that remained attached to the footings were lying on the ocean floor.

We found a 115-foot section still remaining attached at A caisson at the original wreck, which is assisting in holding the wreck into the angle or plane that it is presently in.

Mr. KENDALL. Did you prepare a drawing showing the caisson fractures also, Mr. Crockett?

Mr. CROCKETT. Only of the footed section; not of the ends. However, I do have some photographs that were taken of the ends, but they were taken under adverse conditions, with about 2 or 3 feet of visibility.

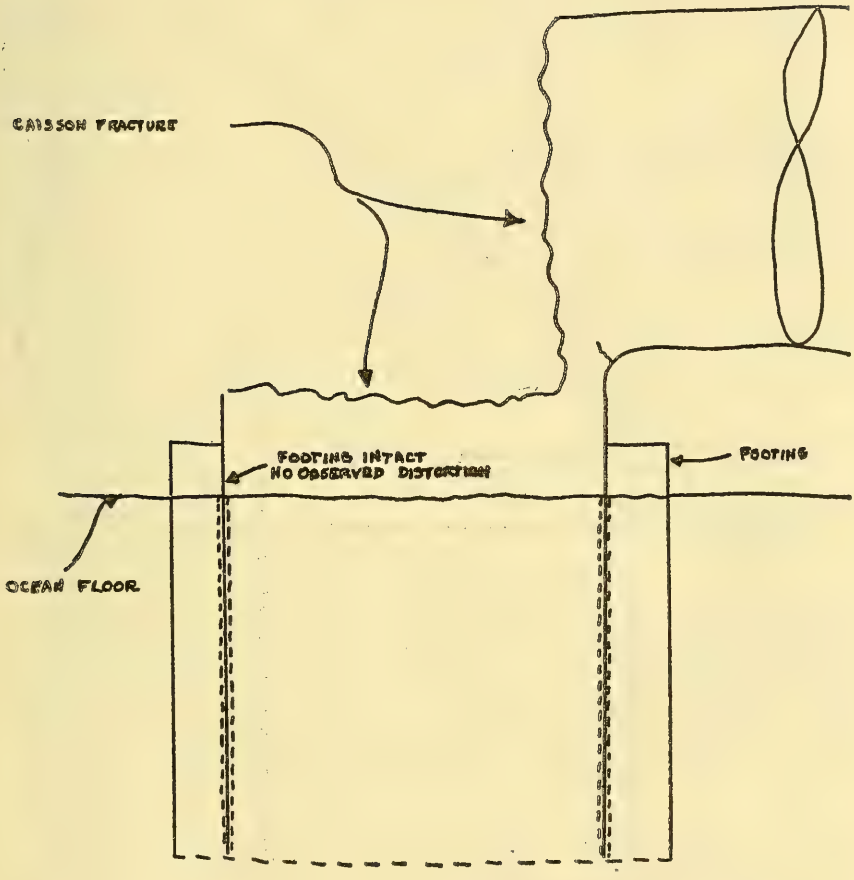
Mr. KENDALL. You have provided us with copies of those photographs, I believe?

Mr. CROCKETT. I have.

Mr. KENDALL. Will you make your drawings of the caisson fractures a part of the record also, please?

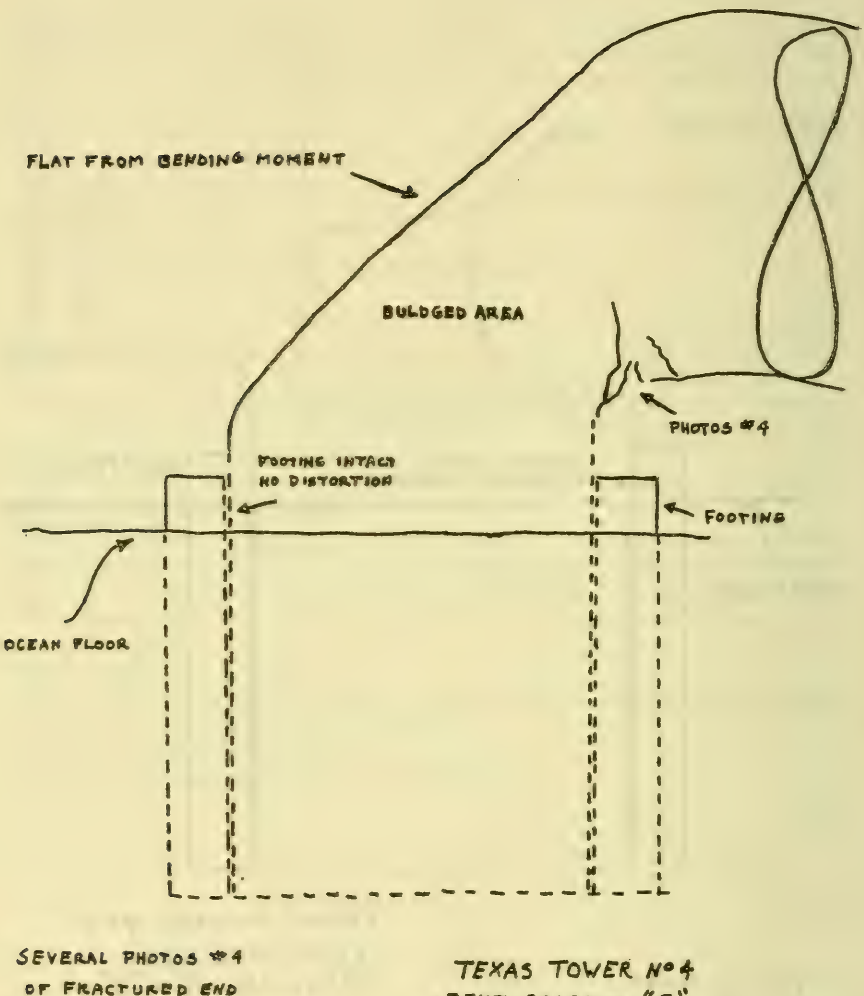
Mr. CROCKETT. Yes, sir.

(The drawings referred to are as follows:)



TEXAS TOWER No 4
TYPE FRACTURE
CAISSON "A" + "C"

CAISSON FOOTINGS
"A" + "C"
PHOTOS SHOW PARTS OF FRACTURE



TEXAS TOWER No 4
BENT CAISSON "B"

Mr. KENDALL. Mr. Crockett, go back for a moment to the installation of the X-bracing last August, I believe it was. Do you now have any opinion as to the effect or result of the installation of that X-bracing?

Mr. CROCKETT. It is kind of like Monday morning quarterbacking.

My opinion has not changed since the outset. I felt that the repairs should have been made from the bottom up, rather than putting the X-bracing in. I feel that the development of that X-bracing put a great big hinge in the caissons above the minus-75- to the minus-25-foot levels. But this is only an assumption.

Mr. KENDALL. Will you elaborate a little on what you mean by a great big hinge?

Mr. CROCKETT. We know there was total loosening of at least an inch in the minus-25-foot panel by actual observation. After the X-ray bracing had been installed and further stabilized the upper panels or sections and reduced slightly the motion, encountering sea conditions that the original design had purposely deleted, the X-ray bracing because of it, had to put an action throughout this minus-25-foot panel on that tower.

Mr. KENDALL. Do you think the installation of the X-bracing had anything to do with the ultimate collapse of the tower?

I mean by that, do you think that it was calculated to prevent the collapse or to cause the collapse?

Mr. CROCKETT. I have no doubt that it was calculated to prevent the collapse.

Mr. KENDALL. I do not mean what the design engineers calculated, but do you have an opinion as to what the actual effect would be?

Mr. CROCKETT. Not as such, no.

Mr. KENDALL. I believe that is all, Mr. Chairman.

Senator STENNIS. Now, on that very point that counsel makes, Mr. Crockett, one of the gentlemen who were here the other day was questioned about that. As I understood his testimony, he said that the X-bracing—that is, the bracing that is represented in red on that model—which was not originally planned to be there and which is above the water, that witness said, as I understand, that due to the obstruction of the waves that were hitting it, it put more force on the tower. Is that not correct?

Mr. CROCKETT. I am inclined to agree with that, sir.

Senator STENNIS. And therefore created more stress and more strain on the tower.

And on the other hand, the X-brace itself taken alone did add certain strength to the tower.

Now, did one offset the other, or is it more probable, in your opinion as a professional man, that the X-bracing made it more likely that the tower would fall under those conditions?

Mr. CROCKETT. I do not feel it is, as such. I feel the continual fracturing of the lower brackets and bracing was the ultimate cause, and very severe sea conditions.

Senator STENNIS. So if I understand you correctly, then, the X-bracing shown in red did not contribute much one way or the other? The added stress or added strength resulting from the X-bracing was not the determining factor, but the original defective condition

below water about which you have already testified was the main contributing factor to the collapse, is that right?

Mr. CROCKETT. I feel that is the case, Mr. Chairman.

Senator STENNIS. Frankly, I think your testimony is very significant on this point, because you are the man who made these inspections from time to time, and you are the man who made inspections after this unfortunate collapse. If I understand you correctly, and I do not mean to repeat, but sometimes that is necessary, the real basic and primary trouble, and cause of this collapse, was those defects which you reported and which had been there to some degree all this time?

Mr. CROCKETT. I did not say that, sir. I do not attribute any one particular thing to the collapse of the tower. In fact, I do not think a man in two shoes exists who does have an opinion as to why the tower collapsed. I think the tower collapse is an act of God, and the reason for this is a continually aggravated failure that there just was not time enough to make the proper repairs before adverse sea conditions kept repeating themselves.

Senator STENNIS. Well, you found those conditions there—I do not remember the dates now that you testified about, but I do recall that the conditions which necessitated the Dardelet bolt repair had been there some 2 years before the collapse.

Mr. CROCKETT. That is quite so, sir.

Senator STENNIS. And when it developed that the Dardelet bolt was not successful, there was an attempt to supplement that Dardelet bolt repair with what you call a T-bolt installation?

Mr. CROCKETT. That is quite right.

Senator STENNIS. And in January 1960, I believe it was, you found the condition was so pronounced that there was a movement in those pin connections of an inch or more; is that correct?

Mr. CROCKETT. Yes, sir, that is very correct.

Senator STENNIS. Then that condition continued to exist on through until September 1960, or thereabouts, when Hurricane Donna came through, which added additional strain. Did you examine it again after Hurricane Donna?

Mr. CROCKETT. No, sir.

Senator STENNIS. That was September, 1960, was it not?

Mr. CROCKETT. Yes, sir.

Senator STENNIS. And this condition continued to exist then, until January, 1961?

Mr. CROCKETT. That is quite right, sir.

Senator STENNIS. During all that time, was there no chance to make effective repairs of these troublesome conditions that became aggravated rather than diminished?

Mr. CROCKETT. I feel that repair by the installation of the X-bracing was an effective attempt, that the designers had done all they thought they could within the time they had to rectify the damage that had been made by Hurricane Donna.

Senator STENNIS. I mean repair below the water, down where the Dardelet bolts were and where the motion was. Was there time to repair that, or was it just a hopeless case?

Mr. CROCKETT. There was a repair instigated there. There was a clamp to be installed in this particular area [indicating] to beef up the weaker section. They endeavored to put some cables on the out-

side—they were endeavoring to put some cables on the outside. At the time the tower collapsed, they were in the process of grouting the A and B caissons. I believe the work predominantly had dealt with A caisson.

Senator STENNIS. I know they were endeavoring to put the cables on there, but they never did get to that, did they?

Mr. CROCKETT. No, sir.

OPPORTUNITIES FOR EFFECTIVE REPAIRS

Senator STENNIS. I am talking about the time element now, and whether or not there was a chance to make the repair. It seems clear to me that this thing continued on for a period of 2, 2½, or 3 years, without anything effective being done with reference to the original trouble with these braces and Dardelet bolts.

Now, further, I understood you a while ago to say that when you discovered this serious situation had developed, you advised that the repairs be made below the water at this original trouble spot rather than the X-braces being installed above the water; is that not correct?

Mr. CROCKETT. That is correct. However, I was not in a position at the time to advise or be consulted as a consultant with regard to this particular operation, sir.

Senator STENNIS. Well, I know, but that was your opinion.

Mr. CROCKETT. That was my opinion, which I so stated.

Senator STENNIS. And instead of making a serious attempt to make further repairs below the water, they installed the X-bracing above water?

Mr. CROCKETT. This was done by people who were better versed than I in the construction field. I am not a civil engineer, sir.

Senator STENNIS. I understand, but you have given us the benefit of your opinion.

I do not know just how the engineers and you gentlemen in that profession use the term "act of God." I have heard that used a good deal in this investigation, and I have a very great reverence for acts of God in law. I am a lawyer myself, and I have some idea what it means there. But it seems to me that to write this off as an act of God is falling far short of the mark. God had a good deal of help in this.

Mr. CROCKETT. I think He did, but I think He generated several of these hurricanes out here, perhaps, that gave us the initial push.

Senator STENNIS. Well, of course, the hurricane or storm, at the time of collapse, would, in law be classed as an act of God.

Mr. CROCKETT. I would like, Mr. Chairman——

Senator STENNIS. Please say anything you want to say, we are trying to get information the best we can.

Mr. CROCKETT. You made the statement that this thing was kind of aggravated over a period of 2 or 3 years. I would like to say that after completion of the installation of the T-bolt connection authorized by the district public works office in Boston, it was my feeling that the tower was within its bounds of original stability. We felt that we had no adverse motion in the pin connections, with the exception of the one that was withdrawn slightly, and it is a possibility that the pin was just not split sufficiently to make it keep intact. But this

was rectified, and the Dardelet error had been rectified, and we feel that at this time, this being June 26 of 1959, the tower was up to its original design.

TOWER AT ORIGINAL STRENGTH, JUNE 26, 1959

Senator STENNIS. Well, that is good. I am glad to hear that clear-cut opinion of yours at this time. That was June 26, 1959?

Mr. CROCKETT. Yes, sir.

Senator STENNIS. That is when you completed one of your inspections?

Mr. CROCKETT. Yes, sir.

Senator STENNIS. Well, my reference to 2 or 3 years of continuing trouble was just a rough estimate, based upon my recollections of the time that the various inspections covered. How much time elapsed from your first inspection until the last one?

Mr. CROCKETT. Oh, 1958, September, until the present.

Senator STENNIS. Well, you were first called in, then, in September of 1958?

Mr. CROCKETT. Yes, sir.

Senator STENNIS. Well, your testimony and the testimony of the gentlemen from the Navy has certainly made much clearer to me, and I believe to the public, the difficulties that were involved in this matter in coping with the weather and in coping with the unfortunate things that happened during the towing and erection of this tower. It seems to have been plagued all the way.

Do you have any other point in mind now that has a bearing on this situation?

Mr. CROCKETT. I do not think so, sir.

Senator STENNIS. I am sure you are willing to bring it out.

Mr. CROCKETT. If I had it, I would.

Senator STENNIS. We certainly want you to have the chance.

Counsel, do you have anything further?

Mr. KENDALL. I have one or two questions.

Mr. Crockett, the storm during which the tower collapsed was not unusually severe, was it? Or do you think it was?

Mr. CROCKETT. I do not have the specific wave heights and the time of the seas.

Mr. KENDALL. You know it was well within the design criteria?

Mr. CROCKETT. I am not even certain of that. I am not in a position to state one way or the other whether it was or was not. I have heard conversations to the effect that it was more severe than the original design criteria.

Mr. KENDALL. The storm during which the tower collapsed?

Mr. CROCKETT. Yes.

Mr. KENDALL. It was not as severe as Hurricane Donna, was it?

Mr. CROCKETT. No.

Mr. KENDALL. Mr. Crockett, you have two other drawings in front of you, I believe, which show the history of the repairs to the tower.

Will you make those a part of the record, please?

Mr. CROCKETT. Yes.

(Note.—The drawings referred to will be found on pp. 25 and 29, respectively, of the subcommittee report on the collapse of Texas tower No. 4.)

Mr. KENDALL. That is all I have, Mr. Chairman.

Senator STENNIS. All right. Thank you.

Now, gentlemen, those of you who have testified already this morning, do you have any point that has come to your mind that you want to bring out and think ought to be put in the record?

(No response.)

Senator STENNIS. All right.

The next meeting of the committee will be at 10 o'clock tomorrow. This completes our testimony for today.

I understand that it will take 1 day beyond tomorrow. I think that most of the high points and major facts have already been covered.

Now, we want to thank you, gentlemen, all of you who testified this morning and others of you who came here with them, for your attention and for your attendance. I think this is very impressive testimony and very valuable in connection with the committee's responsibilities, as well as the Navy's responsibilities, the professional engineers', architects', and so forth.

So again, with the special thanks of the committee, you are now released, those of you who are here under subpena, with the appreciation of all of the members of this committee.

We thank you again, gentlemen, and we will take a recess until tomorrow morning at 10 o'clock.

(Whereupon, at 1:10 p.m., the subcommittee recessed, to reconvene at 10 a.m., on Thursday, May 11, 1961.)

INQUIRY INTO THE COLLAPSE OF TEXAS TOWER NO. 4

THURSDAY, MAY 11, 1961

U. S. Senate,
Preparedness Investigating Subcommittee
of the Committee on Armed Services,
Washington, D.C.

The subcommittee (composed of Senators Stennis (chairman), Symington, Bartlett, Jackson, Bridges, Saltonstall, and Smith) met, pursuant to recess, at 10:10 a.m., in room 235, Old Senate Office Building, Senator John Stennis, presiding.

Present: Senators Stennis (presiding), Symington, and Saltonstall.

Staff members, Preparedness Investigating Subcommittee: James T. Kendall, chief counsel; Stuart P. French, professional staff member.

Senator Stennis. May we have order, please? We want everything arranged where all can see and all can hear, and we cannot accomplish that unless everyone cooperates in keeping reasonably quiet and being attentive.

This morning the subcommittee is privileged to have Mr. Given A. Brewer and Mr. Robert Vanstone as witnesses. Both of these gentlemen are from the Brewer Engineering Laboratories, Inc., of Marion, Mass., and they are here at the request of the subcommittee.

Gentlemen, in keeping with the unbroken custom of this investigating subcommittee all witnesses here are sworn. So if you gentlemen will please rise now you will be sworn.

Do you solemnly swear that your testimony in this hearing will be the truth, the whole truth, and nothing but the truth, so help you God?

Mr. Brewer. I so swear.

Mr. Vanstone. I so swear.

Senator Stennis. All right, gentlemen, have a seat. Mr. Reporter, you have the names of these gentlemen.

The Chair will not review the testimony that was heard yesterday, although the Chair considers it quite valuable.

The Chair reiterates that it is the subcommittee's position to avoid transgressing in any way into any hearing that may be held by the Air Force as a result of charges against military personnel.

We are not going to take any substantive testimony beyond January 12, which was 3 days before the unfortunate collapse of this tower.

Our inquiry is directed into design, construction, and repair of the physical and structural part of the tower. These gentlemen are eminently qualified in this field.

Now, the Chair is going to ask Mr. French, who has been the chief investigator in this matter, and who has done a fine job, to proceed with the examination of Mr. Brewer. All right.

TESTIMONY OF GIVEN A. BREWER, BREWER ENGINEERING LABORATORIES, INC.; ACCOMPANIED BY ROBERT VANSTONE, ASSISTANT ENGINEER TO MR. BREWER

Mr. FRENCH. Thank you, Mr. Chairman.

Your appearance here, Mr. Brewer, is in response to a subpena issued by this subcommittee, is it not?

Mr. BREWER. Yes.

Mr. FRENCH. Would you briefly acquaint the committee with your general professional qualifications as an engineer, and include both your education and experience, please, sir?

Senator STENNIS. Pardon me just a minute, Mr. Brewer; please speak into the microphone so that the committee can hear you.

Mr. BREWER. Yes. Can I be heard satisfactorily? It sounds like I can from the room.

Senator STENNIS. I beg your pardon?

Mr. BREWER. Can you hear me?

Senator STENNIS. Yes, just so you stay directly in line with the microphone.

Mr. BREWER. How is this?

Senator STENNIS. Very good.

Mr. BREWER. Fine.

My background is a graduate from Massachusetts Institute of Technology in 1938. My courses combined mechanical, electrical, and some aeronautical engineering.

Following graduation I joined the Lockheed Aircraft Corp., and I was a structures engineer with that company throughout the war years.

After the war ended, I began as a consulting engineer specializing in experimental mechanics.

This system that I consult in utilizes electronic instruments and electric strain gages to measure stresses and vibrations in structures.

ELECTRONIC INSTRUMENTS TO MEASURE STRESSES AND VIBRATIONS

I utilized these techniques when I was an engineer with Lockheed, and during this period, during the war, I decided that this might be an interesting field for me to conduct after the war.

So I started after the war as an independent consultant, and in the intervening time have conducted some 200 studies on mechanisms and structures utilizing these techniques of electric strain gages, and oscillographic recording devices.

This is a technique that is somewhat like an electrocardiogram, where we paste a strain gage on a structure, such as this tower, and connect it to a machine that looks very much like an electrocardiograph.

Then, as the tower oscillates in the waves, the stresses are converted into electrical signals which then make a wavy line on a paper, and by analyzing these lines you can determine the stresses and the frequencies, very much like a physician does when he analyzes some organ such as the heart in a human being by analyzing this record.

So, very briefly, this is the general technique that I have used to study structures that vary from helicopters to these Texas towers that we have under discussion today.

Mr. FRENCH. Did you have an occasion to conduct a motion study on Texas tower No. 4?

Mr. BREWER. Yes, I did. We installed electric accelerometers and strain gages on Texas tower No. 4 in 1958, and throughout that winter in 1958–59 we had recording equipment on board which recorded the sea height, the wind velocity, stresses on the three legs, and accelerometer motions at three corners of the tower platform.

Mr. FRENCH. Would you tell the committee, please, sir, what the purposes of your study were?

Mr. BREWER. The purpose of this study primarily was to determine the motion of the tower under forces of the sea and air.

RADAR AFFECTED BY TOWER MOTION

It was the primary concern of the Air Force at this time when they activated the tower, it could be observed physically, that the tower was in motion, and the Air Force was concerned with the fact that these motions, particularly if they were rotational, would throw off the base of the radar search, so that the radar search mechanism instead of being on a firm foundation fixed on the earth, would rotate back and forth at an angle and, as a consequence, make, or introduce, an error if you were detecting a bomber in flight.

As a consequence, it was necessary to determine just exactly how much in terms of angle this platform rotated.

Obviously, if it was only a few thousandths of a degree, the error would not be great.

However, if it was on the order of a few tenths of a degree the error would appreciable.

So that the Air Force then commissioned us to determine the tower motions particularly in rotation, how many degrees did it rotate as a function of sea state and wind upon the structure; that was our primary purpose.

Mr. FRENCH. Did your responsibilities include anything in connection with an analysis of the structure itself?

Mr. BREWER. We also were commissioned, secondarily, to measure stresses at the deck, at the juncture of the deck and the leg, that would be at this point [indicating] on the tower, to measure the stresses at that point since they would be the maximum above water stress, and to report them also as a function of sea height and wind force on the tower, to the Air Force.

Mr. FRENCH. Now, prior to conducting any measurements on the motion of the tower did you have any conferences with any representatives of the design firm of Moran, Proctor, Mueser & Rutledge?

Mr. BREWER. Yes, sir. I believe we had two conferences, one at our preliminary meeting and another where we went into the details of the instrumentation, and the data that we hoped to obtain from our installation on the tower. This occurred in New York at the office of Moran, Proctor, Mueser & Rutledge.

Mr. FRENCH. In the course of any of those conferences or discussions, did you acquaint the design engineers with the method and the instruments which you proposed to use?

Mr. BREWER. Yes. At that time, the second meeting, I reviewed the techniques that I planned to utilize to measure the tower motions

and these—I think you can appreciate the fact that on this tower when it is in motion, since you are on the ocean, you have almost no way of determining how much it is moving, because you have no fixed reference point.

FUNCTION AND USE OF ACCELEROMETER

As a consequence, we decided to measure the motion, using accelerometers and, Mr. French, you suggested that it might be well to explain very briefly what an accelerometer is.

I think, perhaps, the simplest or, at least, the most direct analogy would be to point out that the inertial navigation systems used in submarines today, and also in our second line of missiles, employ accelerometers to determine the distance that, and the course that, the vessel or missile has taken.

This accelerometer is actually a weight, and in the case of these accelerometers that we used, the weight is suspended by very fine weblike wires, and these wires, suspending the weight, detect the slightest motion of that weight by straining the wires, and by this strain they change their electrical resistance, so it is possible for us to measure very slight motions of the mass with respect to the earth from these wires.

Now, this is the same principle that is used in inertial navigation in missiles and in submarines; that if you continuously measure the acceleration, and then by mathematical means—double integration, it is called, but it is a mathematical procedure—you can then determine from the slight accelerations what the actual direction and distances are that are traveled by the object.

Dr. Draper, utilizing this device first put it in an airplane, and flew directly by this integrating accelerometer to Los Angeles—this was, I think, about 10 years ago—and it came within 10 miles of Los Angeles.

This device has been improved so that nuclear submarines can operate for several weeks under water, and come up within a fraction of a mile, where they are using techniques such as this one.

We did the same thing. We put three on the deck of the Texas tower, and by recording the electrical output of these accelerometers we were then able to compute the motion in terms of inches.

This was done by double integration, and we did it in this case just by hand mathematics; we did not use any computers.

So that simultaneous with this, we measured bending stresses, and the like, and by correlating the bending stresses in the leg with the motions that we got by mathematical analyses of the accelerometers, we were able to relate the two, so then we could go directly to the strain data on the leg and get the motions. This saved all mathematical analyses, but until you find the correlation between the motions in the leg, the stresses in the leg, and the actual motion in the leg, you cannot tell anything from the stresses.

So once there was established this relationship, we were then able to go rather quickly as far as the analysis was concerned.

Mr. French. Did any of the design engineers object at that time or disagree with the method that you proposed to use?

Mr. Brewer. No, they did not. I believe my memory is correct that Mr. Kuss, of Moran, Proctor, Mueser & Rutledge felt that an

accelerometer measurement, even if it only obtained the frequencies, would enable him to calculate the tower stresses by analytic means.

Mr. French. Did you have any discussion with reference to the extent of platform movement which could occur before the known tolerances in the pins were taken up?

Mr. Brewer. Yes, we did. I am not certain whether it took place at that meeting. If you will excuse me, I have some notes of that meeting.

Not at the first meeting, at least I do not see it here on a quick examination; but we had a second meeting on November 12, 1958, in Boston, and at that time Mr. Kuss, who was in attendance, stated that the tolerances, in other words, the clearance between the pins and bracing here—there are pins that join this bracing to the legs, and those pins, if they fit in a large hole, obviously they will permit some motion of this bracing, which means the entire tower could then go back and forth without utilizing its bracing until the pin fetches up against the other side of the clevis.

MOTION OF PLATFORM PERMITTED BY TOLERANCES

Now, the tolerances at that time, as they were given to me, were about an eighth of an inch, and Mr. Kuss computed that would allow about a 2-inch motion at the platform; that is to say, the tower could move 2 inches back and forth before these pins would take up against the known clearances that were allowed in the design.

Commander Foster at that time stated that during construction of the tower it had been necessary to enlarge these clevises somewhat to permit mechanical assembly, so there were some that were larger and had a greater clearance than an eighth of an inch, which meant it could move, presumably, more than 2 inches before these pins would take up—that is, before the tower would be completely rigid.

So what we discovered on our first measurements was that the tower behaved as if there were no bracing at all. In other words, the tower moves back and forth at a frequency indicated from our instruments that would be the same as if there were no bracing whatsoever under the water, and during that entire winter, where we recorded motions and stresses and waves periodically, we never found excursions sufficient enough to make the tower behave as if the structure down below were indeed clamped tightly.

Senator Stennis. Pardon me. Repeat that, will you, Mr. Brewer?

Mr. Brewer. During the winter we left the instrumentation above the tower for the entire winter, and Air Force personnel ran it for us.

Senator Stennis. Yes.

Mr. Brewer. And this instrumentation recorded the wave height, the wind velocity, wind direction, the stresses in three legs, and accelerometers at three points—all of this information was simultaneously recorded on a graph like the cardiogram.

Senator Stennis. Yes.

Mr. Brewer. Now, from an analysis of that you can tell, and we were able to tell, what the period of motion, that is, the frequency, how many times a minute, the tower oscillates back and forth, and that frequency never changed appreciably during that winter, and that, very briefly, means that the tower bracing down below never came into effect as far as we could determine above the water.

Now, that could be the result of a number of things. This is not to say that the tower bracing was not there.

As I think you will see, if the pins are loose and have a certain amount of clearance, the bracing can still be intact structurally, but the tower can nonetheless move back and forth until these clearances between the pin and the bracing are actually taken up by the excursion of the tower: and, of course, we have no way of knowing what the conditions were underneath the water except that the tower bracing was ineffective within the degree of motion that we measured, which was approximately plus or minus 3 inches.

Mr. French. You also found a degree of rotation before the pins would fetch up, did you not?

Mr. Brewer. Yes. It is a complex motion. The tower is not only going back and forth in a random manner, but it is also rotating in a random manner, and the mechanics of it are such that it probably never repeats itself, because it is a combination of translation and rotation that is set in motion primarily by the waves bearing against the three legs, and the waves themselves are a very random structure, so that the tower never does the same thing twice.

So we took quite a lot of statistical data and made plots and tables from the data that we recorded.

Mr. French. What were the maximum weather conditions which you encountered during your study?

MAXIMUM WEATHER CONDITIONS ENCOUNTERED DURING MOTION STUDY

Mr. Brewer. The maximum—the condition that created the—well, the maximum sea state that we recorded was 30 feet—that was a wave 30 feet in height—and in conjunction with that, I believe it was a 55-knot wind—yes, 55-knot wind and a 30-foot wave. That was the greatest sea state and air state we measured simultaneously.

There were other conditions where we had less waves, that is, waves would not be as high, and the wind would be of a higher velocity.

Mr. French. Under what sea conditions did you find you experienced the maximum translation of the platform?

Mr. Brewer. Curiously enough, this recorded waves of approximately 10 to 12 feet in height. These waves set the tower into greater motion than those of a larger height.

It rather corroborated the experience of the tower personnel who had told me that it seemed to them that sometimes the tower would move or appear to move more with a small sea state than it did on a very high sea state, and for a while we thought this might be due to the pins taking up. That is, on very large waves, perhaps, the tower moved to the point where the pins took up, and therefore it was more rigid, but subsequently we came to the conclusion that the small waves have just the right spacing so that they can strike all three legs simultaneously and, as a consequence, impart more energy into the tower than a single, big wave that hits only one leg at a time. This is our belief.

Mr. French. Well, you are aware of the fact, are you not, sir, that merely a static force analysis was made for the computation of design. Would you kindly define the difference between "static" and "dynamic."

STATIC AND DYNAMIC FORCES DIFFERENTIATED

Mr. Brewer. Yes. A static analysis, I think we could use as an analogy, perhaps, a diving board, a springboard.

If you simply went to the end of the diving board and stood there, you would bend the diving board, and you would have stresses all along the diving board as a simple cantilever beam, and the stresses would be a function of your weight at the end of the diving board.

If you jump up and down on the diving board you would impart greater forces and greater stresses to the diving board. This would be a dynamic loading of a cantilever beam.

Now, if you jump up and down at just the right frequency, and that corresponds with the frequency of the diving board, you can get tremendous stresses and forces into the diving board, so that if the frequency of the dynamic loading corresponds with the resonant frequency—that is the frequency at which the structure itself naturally vibrates at—you can get tremendous vibrations, and this is like a violin string.

When you work a bow over the string, and you do it at just the right frequency, you get very high amplitudes, and it makes a sound. So that dynamic loading, if it is in the right frequency spectrum, can produce loads, produce stresses, in a structure very much higher than the same load would do if it were quite static.

Again, like a person, he still weighs the same amount of weight, but if he jumps up and down on the diving board, he can impart a weight three or four times his own weight to the diving board.

Mr. French. Now, in view of your findings that 10-foot waves caused greater stresses than waves of 30-feet in height, would it be reasonable at least to suggest the possibility that a dynamic force analysis should have been made in computing the design of this tower?

Mr. Brewer. That question, of course, is one that comes up after this was observed.

Now, in the original design, and I was not in on this, and I am merely speaking from what small knowledge I have of the original design, but in the initial design it was assumed by the designer that the underwater bracing would be tight and would be effective, and that the natural frequencies would be about 37 cycles a minute.

When the tower was constructed, the actual frequencies were very much less; they were 19 cycles, and this means that the tower had much greater motion for the same amount of force on it because of the very much lower natural frequency.

So that this condition was recognized at once by the designers and by the people who were responsible for the structure as being bad, and, at the time we were there, they were making strenuous efforts to correct the structure beneath the sea.

In fact, the divers were down, and they were making attempts to put collars on where there had been some damage, and they were making every effort that could be made to try to restore the integrity of the subsea structure. So I cannot really answer that question directly.

The only thing I can say is that if the tower had such a low frequency at the beginning, as a design fact, then certainly it would have been well to look into the dynamics of things.

But the tower, having a low frequency, as it did after it was made, it was apparent to everyone that this was bad, so that it might well have been interesting to and, perhaps, valuable to, make a dynamic analysis, but certainly the first thing to do was to restore the initial integrity of the tower, and they were doing it at the time we were out there.

Mr. French. But would it be reasonable to infer from your findings that the static force of a single 35-foot wave might well be less than the forces exerted by a series of 10-foot waves?

Mr. Brewer. Would you repeat that question?

Mr. French. Would it be reasonable to infer from your findings that the static force of a single 35-foot wave might well be less than the forces exerted by a series of 10-foot waves?

Mr. Brewer. That is possible with the low natural frequency, but actually we know that tuning did not take place, but if you have multiple impacts on three legs which gave forces roughly comparable to the 30-foot wave, and this is borne out by a diagram which is in one of our reports which shows this to be the case, but this is not a resonant phenomenon. It could be though if the tower had an even lower natural frequency; it could be conceivable that it could get resonance with the waves and have some really tremendous stresses and motions. But we have no evidence that suggests that that occurred.

Senator Saltonstall. Mr. Chairman, would Mr. French permit an interruption?

Senator Stennis. Mr. French, I think you have used your time at this point. I yield to the Senator.

Senator Saltonstall. I want to understand, Mr. Brewer, as a layman, what you said about a diving board. I think I understand it.

What you are saying is that if a person out at the end of a diving board is in time with the up and down motion he can produce more dynamic stress than if that person on the end of the diving board gets out of time with the up and down motion.

Mr. Brewer. That is correct.

Senator Saltonstall. And, therefore, it becomes less of a stress.

Mr. Brewer. That is right. His stress still is greater, however, than if he just stands quietly at the end of the board.

Senator Saltonstall. His stress is still greater when he stands quietly?

Mr. Brewer. No.

Senator Saltonstall. No. That is what I understand.

STATIC, IMPULSIVE, AND RESONANT LOADING CONDITIONS

Mr. Brewer. There are three things we are speaking of. If you stand quietly at the end of the board you have a stress on the board that is called a static condition.

If he jumps once on the board, that is called impulsive loading on the board, and that would be greater than a static case.

If he repeats the jumping and gets it just exactly right, depending on the mechanical properties of the board, then he can get an even greater loading, and that is a third thing called a resonance.

We have then a static loading, impulsive loading, and then we have a resonant loading condition. These are the three things that occur.

Senator SALTONSTALL. And what you are saying is that these 10- to 12-foot waves would be right in time with the movement, so that it would cause a greater stress?

Mr. BREWER. No. I wanted to draw a distinction, that the reason that the smaller waves caused more force was because they are just the right spacing, so that they hit all three legs at once. Therefore, you have three times as much force.

Senator SALTONSTALL. I see.

Mr. BREWER. And a single wave hitting one leg, as very roughly you could have one very large wave, if you only struck one leg, and it is down by the time it gets here to the other leg, you really, in effect, are only creating a load on one leg.

Senator SALTONSTALL. What you are saying about the three legs would be like the man out at the end of a diving board keeping in time with the up and down motion of the board.

Mr. BREWER. Well, that would be the resonant case, tuning case.

Let me see if I can think of a better analogy. If you can imagine waves of just the right height so that one was hitting here and another one hitting here simultaneously, that is the condition I was speaking of; whereas, with both the larger wave and the smaller wave, that won't happen. One would be up here [indicating] and down here on this leg.

You see, it takes a unique spacing of the waves to hit all the legs at the same time, and a wave, to do that for this tower, the wave height must be about 12 feet; 10 or 12 feet.

Senator SALTONSTALL. I understand.

Mr. BREWER. If it is a bigger wave, it has a longer period, and it does not do it, later it doesn't do it, and that is not the tuning.

Now, a tuning case, and we have no evidence of this, a tuning case would be if the waves hit a leg at the right frequency of the tower so that each time the tower went back another wave hit it; that is the resonant case, the third condition.

The tower was designed on the condition of one enormous wave striking the leg, which is a static case.

Now, the static case is usually the less force. But again you have to look into the mechanics of the structure to decide whether a dynamic case is worse than the static case.

If you have a very short impulse on a tower that dosen't do nearly as much as one that is on for a longer time.

This has to be done by analysis and, as Mr. French has suggested, a dynamic analysis of the tower might have revealed, under the case that we found, that the loads would be higher.

But this was already recognized as a bad condition, this very low natural frequency, and they were making efforts to stop it, to tighten up, to increase its natural frequency.

Had it been done then, the dynamic loads would not be as great. But this is something that I couldn't say without actually looking into it, and that was not our job.

We were not asked to do that, and we had not done it, so I am speak ing now on the basis of opinion.

Senator Stennis.

Senator STENNIS. All right.

Is there anything further, Senator Saltonstall?

Senator SALTONSTALL. I have some further questions, but I will wait for your interrogation.

Senator STENNIS. I was just going to suggest that we let counsel finish his examination and then we would both proceed.

Senator SALTONSTALL. All right.

Senator STENNIS. All right, Mr. French, you proceed. We will allow you 20 minutes now, or such amount thereof as you may need.

Mr. FRENCH. Thank you, sir.

CRITICISM OF BREWER STUDY BY DESIGN ENGINEERS

Mr. Brewer, in the design and construction report for the Texas towers on page 64, there is a short paragraph that I would like to read to you:

> During the fall of 1958 a subcontract was given to the Brewer Engineering Laboratories, Inc., to perform motion studies on the tower. These consisted of horizontal acceleration measurements in the vicinity of each of the three legs correlated with strain gage measurements on the legs and simultaneous observations of winds and wave direction and amplitude. These studies were not very successful mostly because it was difficult to determine the true translations which involved a multiple integration of the curves obtained from rather irregular data.

Would you kindly address yourself to the criticism that has been expressed?

Mr. BREWER. Where is that statement, sir?

Mr. FRENCH. On page 64 of the Design and Construction Report for Texas towers.

Mr. BREWER. I guess we don't have a copy of that. I see. This actually is a comment on our study by another party, and it says—

> These studies—

which are our studies—

> were not very successful mostly because it was very difficult to determine the true translations which involve the multiple integration of the curves obtained from rather irregular data.

I don't agree with that statement. I feel that our data were quite comprehensive, and that they were accurate, and that it was successful, and we have a number of plots in our reports that show the correlation between the acceleration, the double integration accelerometers with the strain gage information on the legs themselves, and within the limits of experimental accuracy, these data showed a good correlation.

Mr. French has these reports and the plots that I refer to.

Mr. FRENCH. Can you briefly tell us, sir, whether or not in your report the platform excursions coincided with the striking of waves?

Mr. BREWER. They did not. The tower was in motion continuously. We have no records—every record we took, the tower was in motion.

Now, we have simultaneous records of wave passages from the wave staff, together with the tower motions, and they are in the back of one of our reports, and if you examine the oscillograms, you will see the wave passage going by, which appears just like a profile of a wave, but you will notice that the tower motions continued after the wave and they also preceded it; that is, there is enough loading from the waves going by so that the tower—and the tower has such little damping that it is in a state of continuous motion.

Now, the bigger waves, the waves around 10 or 12 feet, do make it move more, and the larger ones move it more, so there is a general correlation between the tower and the wave motion. There is very little damping.

Mr. FRENCH. I believe that in your report you stated, in effect, that if the motion of the tower were objectionable it could be rectified by the installation of above-water X-bracing.

Are you acquainted with the fact that the tower was so designed to keep the resistance to wave passage to a minimum, and would not the installation of above-water X-bracing mitigate against the original design assumptions?

Mr. BREWER. I believe it would mitigate it. You stated "rectify" in your statement. I don't believe I made that statement.

Mr. FRENCH. No, I am sorry. This was just my term.

Mr. BTEWER. Yes, mitigate, I would say. I would feel that X-bracing would mitigate the motions. I did, however, say this was only a suggestion on my part that should be followed by an engineering investigation, because the addition of the X-bracing, of course, would present a greater plan form to the wave which might actually impart greater forces and, therefore, the integrity of the tower might be endangered.

So my suggestion was that the X-bracing be investigated from an engineering standpoint to see if, indeed, it would reduce the motions without endangering the tower.

Mr. FRENCH. Would that require a complete reanalysis of the design computations?

Mr. BREWER. I would think so.

Mr. FRENCH. Would you have an opinon as an engineer as to what the probable net gain in structural integrity would be achieved by the installation of X-bracing?

Mr. BREWER. Well, if you installed the X-bracing, it is conceivable that you might reduce the integrity of the structure. But you would, under the conditions as we did measure them, you would reduce the motions.

If we are speaking of motions, by putting in the X-bracing it would reduce the motions somewhat, but it might increase the loading in very heavy seas on the tower, which might be harmful rather than beneficial.

This is what I meant by having an investigation made before this was done. But I am quite confident that the X-bracing would reduce somewhat the motions of the tower, so if that was objectionable from a radar standpoint, that would be good.

But if it presented a greater profile to the advancing waves so that the tower was then overloaded, that would be bad.

So this is something that would have to be determined by computation investigation.

Mr. FRENCH. We had testimony yesterday that pins were loose in the minus 25 and minus 75 foot levels.

Do you feel that those should have been corrected prior to the installation of X-bracing above water?

Mr. BREWER. Well, I would certainly not be qualified to answer that.

I would think that, first of all from an integrity standpoint, I would feel that the underwater bracing should be repaired, and then to re-

duce the tower motions, the X-bracing might or might not be installed, depending upon whether it would aggravate the loading on the tower, but certainly the underwater bracing must be repaired to make the tower agree with what the designers had planned for in the way of strength and motion, but primarily strength.

Mr. FRENCH. Well, if you had no bracing under water, what would be the effect on that column?

TOWER LEG WOULD BUCKLE WITHOUT UNDERWATER BRACES

Mr. BREWER. We have only cursory computations on this, and these are therefore only given as an opinion. But it appears from these computations that you would have the collapse of one leg if the tower bracing were nonexistent.

Mr. FRENCH. Did you include, within that cursory examination combinations of bracing failure which might lead to column failure?

Mr. BREWER. No, we didn't make that exact computation. This was just a quick column computation, and it was based on assuming that the concrete maintained its bond, and also assumed fixity of the ocean floor and some other things like that; and again, I must add that this was a very cursory computation. But it did appear that the column failure was—it was marginal so far as strength in a simple column, and actually this was a beam column, which makes things even worse.

Mr. FRENCH. Mr. Chairman, we would like to have the reports of Brewer Engineering Laboratories, Inc., introduced as part of the official files of the subcommittee.

Senator STENNIS. Very well. It will be incorporated at this point, Mr. Reporter.

(The document referred to will be found in the subcommittee files.)

Mr. FRENCH. I have no further questions, Mr. Chairman.

Senator STENNIS Mr. Brewer, I have a few questions to ask.

It seems to me, if I understand the latter part of your testimony, that you said that unless the integrity of the tower bracing was restored beneath the water, in your opinion, that it would lead to a collapse of the tower.

Did I understand you correctly?

Mr. BREWER. No——

Senator STENNIS. I want to be certain.

Mr. BREWER. No. The question, I believe, was, should the tower bracing be repaired before the X-bracing was installed.

Senator STENNIS. Yes.

RESTORATION OF SUBSEA BRACING DEEMED MOST IMPORTANT FACTOR

Mr. BREWER. And I felt that the most important thing was to try to restore the integrity of the bracing beneath the sea.

Senator STENNIS. Yes.

Mr. BREWER. Because unil that was done the tower did not have the strength that the designer had planned for.

Senator STENNIS. Yes.

Mr. BREWER. This is an opinion.

Senator STENNIS. Well, I understood that.

Mr. BREWER. I would not predict collapse.

Senator STENNIS. I thought you added something about the collapse of a pier.

Mr. BREWER. I said——

Senator STENNIS. I do not know just how you connected it to your other testimony.

Mr. BREWER. No. The thing we said about the collapse of the pier, if the bracing beneath the water were nonexistent, let us suppose all the pins fell out or all the braces broke so that none of the structures were present, then we have the feeling from very limited calculations that one of these legs would have collapsed; that is, would have buckled, which would have allowed the whole tower to come down.

Senator STENNIS. Yes.

Mr. BREWER. So obviously, since we know from our investigations above the water that this bracing is ineffective mathematically, something should be done to restore its effectiveness.

Now, we have no way of knowing above the water whether this bracing was ineffective merely because the pins were in large holes, which is not very serious, or whether there were actual members that were missing, so that you would have to refer then to the testimony of the people who made the underwater inspection to determine just what was wrong with the undersea structure.

Our above-sea measurements indicated that it was totally ineffective. That means it is either gone or loose.

Senator STENNIS. Well, that is a very impressive point. I wanted to review it not just for the purpose of repetition but to be certain that I understood you correctly.

Based upon the instruments which made these recordings, your conclusion was that these braces down there, for some reason, were ineffective?

Mr. BREWER. That is correct.

Senator STENNIS. You are not expessing an opinion on what the reason was, because you did not go below water. Is that correct?

Mr. BREWER. That is right. We have no way of knowing that.

Senator STENNIS. Thank you, sir.

Senator Saltonstall, do you have any questions?

Senator SALTONSTALL. Thank you, Mr. Chairman; just two or three questions, Mr. Brewer.

Mr. Brewer, you were employed by the Air Force; is that correct?

Mr. BREWER. Indirectly. We had a contract with the Hallicrafters Corp. of Chicago who, in turn, have an Air Force contract, and this was just a mechanism; the Hallicrafters Co. takes small contracts, deals with small contractors, so the Air Force has an overall contract with them which will pick up these small contracts. That was the reason for doing this.

Senator SALTONSTALL. And what company was responsible for the radar and the instruments, and so on?

Mr. BREWER. Which company was that?

Senator SALTONSTALL. What I am trying to get at is, you say you were employed by the——

Mr. BREWER. Hallicrafters Co.

Senator SALTONSTALL. What company?

Mr. BREWER. Hallicrafters, H-a-l-l-i-c-r-a-f-t-e-r-s.

Senator SALTONSTALL. You were employed by the Hallicrafters Co.?

Mr. BREWER. Correct.

Senator SALTONSTALL. What was the relationship of the Hallicrafters Co. with the Air Force?

Mr. BREWER. They had a general contract, sort of a catchall contract, so that small contracts that come up from time to time during the year are done through them, and then they are on an overall contract with the Air Force. Apparently it is too complicated to have a small contract such as ours negotiated each time with the Air Force, so that all of these small contracts go through a larger company.

Senator SALTONSTALL. The Air Force was responsible for the safety of the tower, was it not?

Mr. BREWER. I believe at that time the Navy was responsible.

Senator SALTONSTALL. Mr. Chairman, that would be in direct conflict to the testimony we received yesterday. Are you sure of that, Mr. Brewer?

Mr. BREWER. No, I am not sure of that.

Senator SALTONSTALL. What I would like to try to get at is this: We are told that the Air Force took over this tower from the Navy in December of 1957. You were working in 1958–59, were you not?

Mr. BREWER. That is correct.

Senator SALTONSTALL. And you were working for this——

Mr. BREWER. The Air Force; that is right.

Senator SALTONSTALL. Were you working for the Air Force through this Hallicrafters Co.?

Mr. BREWER. That is right.

Senator SALTONSTALL. What is the relationship, so far as you know, between the Hallicrafters Co. and the Air Force?

Mr. BREWER. They are a contractor to the Air Force.

Senator SALTONSTALL. The Air Force had taken over the tower, had it not?

Mr. BREWER. I couldn't tell you.

Senator SALTONSTALL. You couldn't tell that?

Mr. BREWER. It was my impression that the Navy was responsible for the structure of the tower at that time, but it is only my impression.

The Navy was in charge of making the subsea repairs at the time I was there, and the Boston Navy Yard——

Senator SALTONSTALL. So you were not directly employed by the Government?

Mr. BREWER. No; indirectly.

Senator SALTONSTALL. Now, who asked you to go out there?

Mr. BREWER. We were asked by the Cambridge Air Force Research Center to submit a proposal to measure the motions of the tower; that is, through Cambridge, through the Mitre Office in Cambridge, through a Mr. Donegan. He is an Air Force civilian employee.

Senator SALTONSTALL. Did you have anything to do with the tower prior to the time that you went out there?

Mr. BREWER. I had measured some motions on Texas tower No. 2, 2 or 3 years before, and therefore I had some prior experience on this.

This was done for Lincoln Laboratory at MIT.

Senator SALTONSTALL. But you had nothing to do with the design of the tower?

Mr. BREWER. No, I had nothing to do with the design of the tower.

Senator SALTONSTALL. From your study out there and from your

examinations of these motions, and stresses, have you any opinion as to whether the original design was adequate and proper for the purpose?

Mr. BREWER. I wouldn't have any opinion on that.

Senator SALTONSTALL. You would have no opinion on that?

Mr. BREWER. No. The only opinion I would have is the one I gave, which is that the subsea structure appeared to be totally ineffective, and this was reported.

You see, my primary responsibility was to measure how much it moved from the radar standpoint.

Senator SALTONSTALL. Would you repeat that, please?

Mr. BREWER. My primary responsibility was to measure how much this tower moved back and forth and around and around because it affected the accuracy of the search radar; but, secondly, I did measure the stresses and was asked to measure the stresses, which I did.

Senator SALTONSTALL. We have had considerable testimony concerning the use of pins as opposed to welded connections. In your opinion, was it properly constructed?

Mr. BREWER. I never went underneath the water to look at anything, and the only knowledge I have of that is just talking to the divers and talking to the Navy people, and we have transcripts of that in our reports of these conversations.

Senator SALTONSTALL. So that you have no opinion on the question of pins versus welding, or the tolerances of the pins, and so on?

Mr. BREWER. We have no direct knowledge of this.

Senator SALTONSTALL. You have no direct knowledge of that. You never made any underwater inspection?

Mr. BREWER. That is correct. We never went underwater.

Senator SALTONSTALL. Did you approve of the strengthening above the water, by the use of X-bracing as shown on the model in red?

Mr. BREWER. I think I have to go into that a little bit. I suggested that would be a worthwhile avenue to investigate, putting X-bracing above the water. But I said this is a suggestion. But that it should be investigated from an engineering standpoint, first, to see whether it would be actually helpful; it was my opinion it would be helpful.

So when you ask did I approve, I did not. I suggested that this would be a worthwhile avenue to investigate.

I was never asked to approve it, and I never made any measurements on it.

Senator SALTONSTALL. I see.

So you took no responsibility for offering an opinion as to whether this strengthening above the water, as shown on the model in the red, was adequate or not?

Mr. BREWER. Well, my suggestion was that the X-bracing might be added to reduce motion and not to necessarily strengthen the tower.

But I did suggest that this should be looked into because it might well have the opposite effect as far as strengthening the tower. So I never made any drawings or calculations of anything.

This was simply a suggestion I gave to the Navy people when we were discussing the motions that I had made otherwise.

Senator SALTONSTALL. You told Senator Stennis, if I heard it correctly, and I would like to repeat it because I think it is very important, you told him that the above-water inspection showed that the

70733—61——14

underwater braces were ineffective. Did I understand you correctly?

Mr. Brewer. That is correct. The motions, in other words, from the measurements we were able to conduct above the water, which were measuring stresses in these legs above the water, and measuring the motions from the accelerometers, we were able to calculate that the tower behaved as if there were no bracing whatsoever under the water.

Senator Saltonstall. Your work was to determine the motion of the tower?

Mr. Brewer. That was our primary purpose.

Senator Saltonstall. In your opinion, was the motion of the tower increased or diminished by the bracing above the water that is shown in red on the model?

NO MEASUREMENTS MADE AFTER X-BRACING INSTALLED

Mr. Brewer. We never measured it after that. I suggested that that would be a worthwhile endeavor, but we were never commissioned to do that, so we have never been on the tower since the bracing was put in.

Senator Saltonstall. But you did have an opinion that the bracing above water would not strengthen the bracing below, if the bracing below was ineffective?

Mr. Brewer. That is correct. All it could do was reduce somewhat the motions of the tower.

Senator Saltonstall. Yes.

One other question: You went into this analogy of the diving board, and a 10- to 12-foot wave, as opposed to the 35-foot wave.

What would be the effect on the bracing above the water, as shown in red on the model, as affecting the length of the wave, and striking the legs of the tower, if any?

Mr. Brewer. Actually what we were speaking of, where it hits all legs simultaneously there would be no force change provided the waves didn't hit the bracing. I said there would be no difference.

Senator Saltonstall. No difference.

Mr. Brewer. As long as it didn't hit the bracing, as long as it didn't hit the bracing.

Senator Saltonstall. In other words, the effect of a 10-foot wave on the tower, the dynamic movement, to use your expression——

Mr. Brewer. Yes.

Senator Saltonstall (continuing). Would not be affected by the bracing above the water.

Mr. Brewer. Well, the movement would, but not the stresses. Perhaps I did not understand your question. I would expect that with the 10-foot waves, and with the bracing, the tower would not move as much as it did without the bracing. But I would expect the stresses would be very much the same; that is, you would not change the stresses in the steel, but you would reduce the motion somewhat, provided the waves didn't hit or were not sufficiently large to hit, the bracing.

Senator Saltonstall. One final question: Did the motion of the tower increase, during that winter when you were making these examinations? You made them between November and March, didn't you?

Mr. BREWER. That is correct.

Senator SALTONSTALL. In the winter of 1957 and 1958 or 1958 and 1959?

Mr. BREWER. 1958 and 1959, right.

Senator SALTONSTALL. Did the motion increase, from November 1958 to March 1959?

Mr. BREWER. It seemed to be primarily related to the sea height, that is, we have a plot—I can quote that—we have a figure which, I think, illustrates it better than words.

We have plotted tower motion against wave height, and throughout this period you will see this, that there is a correlation here between the motions of the tower and the height of the waves that were impinging on the tower, and from that you will also see that the waves in the 10- to 12-foot category had almost or as great an effect as the waves way up in the 30-foot category because of the simultaneous loading of the legs which I mentioned earlier. That, for the record, is our figure 17, in report 173.

Senator SALTONSTALL. Did you give an opinion to your employer, the Hallicrafters Co., that the tower was safe or unsafe, from your observations?

Mr. BREWER. I am not sure; I don't believe we gave any opinion as to that. I think we merely said that the stresses that we measured above the deck were moderate at that point.

Senator SALTONSTALL. So that from your observation and examination, in terms of your employment, you had no opinion as to whether the tower was unsafe for the purposes for which the Air Force was using it, during your examination or afterward?

Mr. BREWER. Well, we had no opinion on it because we don't know the conditions beneath the sea. The stresses beneath the sea could be very materially higher than those we measured above.

KNOWLEDGE OF CONDITIONS OF SUBSEA BRACES WOULD AID ABOVE-WATER STUDY OF STRESSES

If some of the bracing was gone, and if someone could tell us exactly what braces were gone or what the structure beneath the sea was, we could then make some rather accurate calculations of what the stresses were, and they could be very appreciably higher than those we measured above. But this is contingent upon an exact knowledge of the subsea structure, and we never had that knowledge.

Senator SALTONSTALL. Were the stresses excessive at any time, in your opinion, at the maximum of the 10- and 12-foot waves which were causing the most motion of the platform?

Mr. BREWER. They were not excessive where we were measuring them; no.

Senator SALTONSTALL. So at the point where you measured the stresses on the legs and bracings and while you were measuring them, the stresses were never at any time excessive?

Mr. BREWER. Well, they could be underneath the sea.

Senator SALTONSTALL. I see.

Mr. BREWER. We don't know what is going on beneath the sea, sir; you see, that is our problem.

All we know is what we measure above the sea.

Now then, if this bracing, for example, is all gone, there is some indication from some quick computations made that actually you could have complete collapse of one of these legs without any severe forces put on them.

If all these bracings were gone, it is rather likely these legs would simply buckle because they were too long, so you wouldn't need any waves at all.

Another factor was if some of these braces were gone, then down near the footing on the bottom of the leg you could have stresses, perhaps, three times as high as we measured up here.

Now, when you have stresses three times as high, moderate up here, down here [pointing to ocean floor] they might not be moderate when you consider the salt water and, perhaps, holes and things like that, but that is speculation because until someone tells me that the structure is like underneath the sea, I could not possibly tell whether the stress is three times as much; I could merely say it could be three times as much if the structure is gone.

I could also say it may be likely that you could have column failure in one of these legs without any waves, provided that all the structure is gone.

You see, this is all contingent on knowing something that I don't know, what is the condition of the subsea structure.

Senator SALTONSTALL. What you emphasize to us is that this bracing above the water, as shown in red, was ineffective to strengthen the tower if the braces below the water were gone or were not sufficient.

Mr. BREWER. Well, it would help partially. For one thing, this column failure is a matter of length. Therefore, you shortened the column by putting these braces in, so speaking of pure column failure these braces have indeed helped out, even though this structure might be gone down here [pointing], from the standpoint of deflection, this bracing has helped it because it has reduced the motion of the leg and, therefore, the motion force.

However, if under heavy seas they present a profile to the waves, that increases vastly the force on the tower and then, perhaps, they have made things worse. But these things can only be determined by an analysis which we did not make.

This was a conversational opinion which I gave to the Navy on one of the trips back when I suggested that they look into the possibility of this for reducing motion, and it was not made to reduce stress or improve tower integrity.

Senator SALTONSTALL. But, if the bracing below the water were gone, then the braces above the water, shown in red, would not be sufficient to hold the tower in place.

Mr. BREWER. Well, I would hate to say that without making an investigation.

As I say, a cursory investigation that we made indicated you could still have column failure if you lost all the bracing.

Senator SALTONSTALL. You could still have what?

Mr. BREWER. Column failure; that is, one of the legs could buckle simply from the weight.

You see, the weight of the tower if you have no bracing here is sufficient to buckle these legs; they would just fail like straw because they were too long, so the bracing exerts, among other factors, a stabilizing influence on these legs so they don't buckle.

Now then, if all the bracing were gone and you don't have the X-bracing, it is far more likely that the buckling of this leg would occur without any wave forces being put on the tower at all.

Senator SALTONSTALL. You would have no opinion regarding this method of construction of the tower as opposed to the construction in towers No. 2 and No. 3?

Mr. BREWER. Well, they were vastly different, of course. Texas tower No. 2 has no bracing either above the sea or below and it is in much shallower water, so the legs themselves resist these translational forces from the waves, and the natural frequencies are very high on tower No. 2; and, well, the stresses are just a tiny fraction, and the motions themselves are in the order, I think, of a few hundredths of an inch as compared to several inches on this. So they are not at all similar.

Senator SALTONSTALL. Thank you, Mr. Chairman.

Senator STENNIS. Thank you, Senator.

Senator Symington?

Senator SYMINGTON. Mr. Brewer, did I understand you to say that you have no opinion about the original design, as to whether it was right or wrong?

Mr. BREWER. That is correct.

Senator SYMINGTON. That is because you were not in on the original design?

Mr. BREWER. That is correct. We had nothing to do with the design of the towers. We were merely asked to measure the motions of the tower so the Air Force could determine whether there would be large search radar errors.

Senator SYMINGTON. If you were asked to measure the motion of a skyscraper that had been up for 5 years, and then in the sixth year it fell down, you would still feel that you did not have a right to say whether or not it was designed properly in the beginning?

Mr. BREWER. Well, I think I understand the meaning of what you are saying.

Senator SYMINGTON. It seems to me, based on your testimony, you have said that many things were done to correct this tower, but that those things weren't adequate. Nothing would have had to be done to correct it if the original design had been adequate, would it?

Mr. BREWER. Well, the original design I can't comment on. I believe it was adequate, but what I do want to point out was that this tower was not built in accordance with the original design.

Senator SYMINGTON. Then let us shift it and say the original construction was inadequate.

MEASUREMENTS ABOVE THE SEA INDICATE THAT SUBSEA BRACES ARE INEFFECTIVE

Mr. BREWER. The original construction had either, because of failures in transport or for reasons unknown to me, resulted in a tower

that behaved as if there were no subsea structure. This we observed, and this we reported, that our measurements above the sea indicated that the subsea structure was totally ineffective.

Now, we weren't charged with the responsibility for finding that out. However, we found it out, and we felt we should report this, and we did.

Senator SYMINGTON. I understand that.

It is sort of a Tinkers-to-Evers-to-Chance as to responsibility. I am sorry I have been out of town and not present for some of these hearings, but I wonder why, if the design was all right, or the construction was all right, or both were all right—why if it was right, you wouldn't have to do all this repairing, would you?

Mr. BREWER. Yes. The reason they tried to fix it is because it was not functioning according to design.

Senator SYMINGTON. That is my point.

Mr. BREWER. The tower was moving more and moving at a lower frequency, and this was detected by our instrumentation, and the people responsible for the tower were making efforts while we were there to rectify the condition by sending down divers and making repairs.

Senator SYMINGTON. That was my point.

Mr. BREWER. It was my suggestion after they make repairs we could come back and measure the motions again, and ascertain whether it had been improved or not. This was not done.

Senator SYMINGTON. To whom did you suggest that?

Mr. BREWER. I have a letter. If you will excuse me a minute I will see if we can find a letter.

Senator STENNIS. Yes.

Mr. BREWER. It is a rather simple thing. If they were able to restore the integrity of the subsea structure, then the natural frequency would go up to the 37 cycles that the designers had calculated, and if that was the case, the motion would go down, and probably the stresses. But this could be determined by an experimental program, and I did suggest that, and we may be able—if we cannot find the letter right here, we can——

Senator SYMINGTON. If you give the contract to a reputable contractor based on his statement that a design is right and have a production contract, generally when you start creating the building, you do it under a performance bond and then somebody is responsible for not building it in accordance with the design.

In this case, what I am interested in is: Who is responsible for these men getting into this trouble? It seems that there was a great deal of effort to repair an obviously faulty tower, and that effort did not result in the desired end.

BREWER LABORATORIES NOT CONNECTED WITH DESIGN

Mr. BREWER. Well, I would like to say at the outset that we had nothing to do with the design of this tower, and the reason we were brought in, the only reason we were brought in, was because when the tower was first occupied, these motions were noticed by the personnel on board, and it was not known at that time how much the

motions were because there was no one who could think of a way to measure it.

So, because of my experience on tower No. 2, I was engaged to measure the motion, so that the people could tell whether they were a matter of an eighth of an inch or 8 feet, because speculations ran in that whole spectrum.

So our job was, and our responsibility was, not to design or to pass on the design or to pass on the danger or anything else, but simply to measure how much were the motions and, in conjunction with measuring the motions, what were the stresses at the deck.

This we did, and this was reported to the designers, who have a far greater knowledge of the integrity and the considerations of this tower than I do.

Now, if someone had asked us to design the tower and to make a stress analysis of the tower, that would be another matter. But we were not asked to do that, and we were brought in after the tower was built.

Senator SYMINGTON. I understand that, and let me hasten to say in no way am I criticizing anything you did or didn't do. As you give your testimony, it appears that perhaps if they had taken your advice for another look based on your calculations, maybe this could have been avoided.

It couldn't have been built right in the beginning. That couldn't be possible, if by right is meant that the tower was supposed to stand up.

I have no further questions, Mr. Chairman.

Senator STENNIS. Thank you, Senator.

Mr. Brewer, you have said now that you made a report and a recommendation, and you were not called back to make a further test.

Did you find your letter?

Mr. BREWER. Yes. I can quote from this letter; it is dated June 16. It is to the Air Force, Cambridge Research Center.

Senator STENNIS. Well, do you mind if we just put it in the record?

Mr. BREWER. All right; just put it in the record.

Senator STENNIS. All right. You may read it and then we will put it in the record in toto.

Mr. BREWER. I will just read——

Senator STENNIS. The pertinent parts.

Mr. BREWER. I will just read this one paragraph, and I quote:

Senator STENNIS. Give the date, Mr. Brewer.

Mr. BREWER. June 16, 1959:

> I believe an engineering study should be made evaluating quantitatively the several methods proposed for reducing tower motions.

Then:

> I would like to suggest for your consideration that a task be organized to make an engineering study of the various methods of TT–4 reinforcement, together with a prediction of the excursion reduction due to this reinforcement.
>
> I also recommend that we reinstrument the platform again this coming winter to determine whether or not the underwater reinforcements now being carried out by the Navy have been effective in reducing tower excursions.

Senator STENNIS. All right, Mr. Reporter, put the entire letter in at this point.

(The document referred to follows:)

JUNE 16, 1959.

Mr. JOHN F. DONEGAN,
CRLD, Air Force Cambridge Research Center,
L. G. Hanscom Field, Bedford, Mass.

DEAR JOHN: By this time you will have received our Report 173, describing the motions and stresses of the TT–4 platform, as observed through the winter of 1958–59.

I believe an engineering study should be made evaluating quantitatively the several methods proposed for reducing tower motions.

Because of our experience in measuring the tower's excursions, and identifying the origins of these excursions, I believe we are in a good position to carry out further analyses.

I would like to suggest for your consideration that a task be organized to make an engineering study of the various methods of TT–4 reinforcement, together with a prediction of the excursion reduction due to this reinforcement.

I also recommend that we reinstrument the platform again this coming winter to determine whether or not the underwater reinforcements now being carried out by the Navy have been effective in reducing tower excursions.

Yours very truly,

GIVEN A. BREWER, *Chief Engineer.*

Senator STENNIS. Mr. French, do you have anything further?

Mr. FRENCH. I have no further questions, Mr. Chairman.

Senator STENNIS. Senator Saltonstall?

Senator SALTONSTALL. No questions.

Senator STENNIS. Senator Symington?

Senator SYMINGTON. No questions.

Senator STENNIS. We appreciate your coming here, Mr. Brewer, and I believe your testimony has been very relevant and very revealing in many ways. As I understand it, your examination and study, aided by the recordings of your instruments showed that the bracing of the structure under the water was totally ineffective.

Mr. BREWER. That is correct.

Senator STENNIS. Yes. And you were never called back any more after your first examinations and your first recordings——

Mr. BREWER. Well——

Senator STENNIS (continuing). For similar work, I mean.

Mr. BREWER. That is right. After they made the reinforcements and put in the X-bracing and these things, we were never called back again; that is correct.

Senator STENNIS. All right.

We thank you very much, and you, too, Mr. Vanstone. You are here under subpena, and we appreciate very much your coming here, sir.

Is there anything further?

Mr. BREWER. Sir, there is one thing Mr. Vanstone pointed out which should be in the record, and that is what we said about it being totally ineffective under the water applies to the excursions we made which were plus or minus 3 inches.

Now, no one can say if it moved 4 inches they might have been ineffective. If it were due to pin looseness, you can imagine if it went 4 inches, maybe the pins would take up.

GREATEST MOTION DETECTED WAS PLUS OR MINUS 3 INCHES

At least within the range we measured that winter, the bracing within the sea was totally ineffective, but this must be qualified by

saying that the greatest motions we observed, measured, were plus or minus 3 inches.

Senator STENNIS. That means 3 inches one way and 3 inches the other way?

Mr. BREWER. Yes. For that range there was no evidence that the underwater bracing was helping at all, helping this structure.

Senator STENNIS. Well, my impression is that this is the most revealing testimony on this point that we have had.

Senator SALTONSTALL. Would the Senator yield?

Senator STENNIS. Yes.

Senator SALTONSTALL. Would I understand, just to make it clear to a layman's mind, that because of this 3-inch motion above the water you came to the conclusion that the braces under the water within those 3 inches were not effective at all?

Mr. BREWER. That is correct.

Senator SALTONSTALL. Did the bracing become effective if the motion was greater than 3 inches?

Mr. BREWER. Well, they could be. You see, we have no way of knowing, because 3 inches is the greatest the tower ever moved that winter.

Senator SALTONSTALL. I see.

Then the most motion that you detected above water was the 3-inch motion?

Mr. BREWER. That is correct.

Senator SALTONSTALL. And that 3-inch motion was something which proved to you that the underwater bracing was not doing its job?

Mr. BREWER. That it wasn't doing anything over that range; we knew that.

Senator SALTONSTALL. Yes. Thank you.

Senator STENNIS. All right. Thank you again, gentlemen. Thank you very much for your testimony.

We have as the next witness Mr. E. G. Rau, who was the chief engineer for the contractor who had the responsibility for the construction of this tower.

Mr. Rau, will you come around, please, as soon as these gentlemen have left the table.

All right.

Mr. Rau, you understand that it is the unbroken custom of this committee to have witnesses sworn.

Do you solemnly swear that your testimony here at this hearing will be the truth, the whole truth, and nothing but the truth, so help you God?

Mr. RAU. I do.

Senator STENNIS. Are these gentlemen who are with you going to testify?

Mr. PILZ. No. Mr. J. Rich Steers is on the right side, and I am the counsel.

Senator STENNIS. You may advise the witness of course. Mr. Rau, we are glad to have you here, sir. We have had other testimony about this matter, and we always like to have the gentleman here who did the actual work and construction.

Mr. RAU. Thank you, Senator.

TESTIMONY OF EUGENE RAU, VICE PRESIDENT AND CHIEF ENGINEER, J. RICH STEERS, INC.; ACCOMPANIED BY J. RICH STEERS AND EMIL V. PILZ, ATTORNEY

Senator STENNIS. Mr. Kendall will proceed with his questioning. You have no prepared statement?

Mr. RAU. I have no prepared statement, Senator.

Senator STENNIS. Do you have a preliminary statement?

Mr. RAU. I would like to make a preliminary statement.

Senator STENNIS. Let him first identify you properly for the record, so we can get your connections and background, then you can make a statement as you see fit, and then counsel can ask questions.

Mr. KENDALL. Mr. Rau, first, I believe you are here as a result of a subpena issued by this committee?

Mr. RAU. Yes, I am.

Mr. KENDALL. What is your connection with Texas tower No. 4?

Mr. RAU. While I was vice president and chief engineer of J. Rich Steers, Inc., I was fully cognizant of the construction. We were doing the construction of Texas towers No. 3 and No. 4.

Mr. KENDALL. J. Rich Steers was the contractor who built the tower under a joint venture with Morrison-Knudsen; is that correct?

Mr. RAU. We were the sponsors under a joint venture; that is right.

Mr. KENDALL. I believe you indicated you would like to make a preliminary statement. You may do so.

Mr. RAU. Well, to give quickly my past experience——

Mr. KENDALL. Yes.

Mr. RAU (continuing). I am a graduate engineer, graduated from the University of Notre Dame in 1933.

I joined J. Rich Steers, Inc., about 6 months after graduation and have been associated with this organization ever since, except for 2½ years of service in the Civil Engineer Corps, U.S. Navy, during World War II.

I have a professional engineering license in a number of States, and I have the title of vice president and chief engineer which I have held for some 13 years.

In turn, the firm of J. Rich Steers was founded at the turn of the century, at which time it was known as Henry Steers, Inc., and it was changed to the present name in 1929.

We are a heavy construction outfit doing all types of heavy construction, but in general, more marine work than land work.

Since, during and since the war, we were involved in the construction of the Brooklyn Navy Yard, which amounted to some $80 million; we were involved in the construction of Wheelus Field at Tripoli in Libya; Port Lyautey, French Morocco; Asmara, Eritrea; the Voice of America station in Tangiers; the rehabilitation of the harbors in Greece under the Marshall plan.

We were involved with the construction of early warning radio stations in Greenland, and just this past winter we finished a management contract that we had for the construction of radio station WFAU–FM which, incidentally, was completed a number of months ahead of schedule, and was able to be put into service.

We have done a number of marine construction jobs such as piers, breakwaters into the Atlantic and Caribbean, and we have done a lot of complicated towing in the Atlantic Ocean.

So with this past experience of marine work, when the Texas tower program became a fact back in September of 1955, we thought we would like to put a bid in for it.

After all, the construction of these towers, to us, was a marine problem.

The only thing that we did not fully have experience on was the jacks and the jacking assemblies and the actual jacking up of the towers.

Therefore, we associated ourselves with Morrison-Knudsen in September of 1955, because they had with them a man named Lucas, who was a former partner of DeLong's for a number of years, and had experience, a number of experiences, in jacking up the platforms.

As you know, we submitted our proposal November 1, and it was accepted in the latter part of November.

Soon after that we started to order our materials under the priority allocation that we had, but within a month or so this proved to be ineffective. We had trouble getting materials or at least getting them on order and getting them delivered in time to construct, which we had to do under our contract, both towers in 1956.

The first part of January of 1956 we brought this to the attention of the Navy, and it was then decided instead of concentrating on two towers and end up by not building either one that year, we should concentrate our materials, our allocations, to one tower, and be able to start one in the year.

We decided to start Texas tower No. 3 first, so that at the completion of this fabrication, which was done in Portland, Maine, we sailed on August 7, 1956, to emplant Texas tower No. 3 some 65 miles southeast of Nantucket.

As you gentlemen may recall, this was only 3 days before what we had been warned was the beginning of the hurricane season.

We did this because of the fact that we were told it was most important to emplant these towers for the defense of our country. It was part of our early warning system.

We got the tower out on site, and had it jacked up only 10 feet above water when actually a hurricane came up the coast and, fortunately, veered east of us and missed us by about 100 miles.

You can well imagine what would have happened to the tower and 130 men we had aboard if it had continued on its original path.

We completed the installation of Texas tower No. 3 in the winter of 1956 and, as I recall, it was actually—we actually removed our men from the tower in March of 1957.

At this time we concentrated our full effects or efforts on the construction, fabrication, of Texas tower No. 4.

This tower, being the first of its kind ever attempted, why, it was quite a challenge engineeringwise and otherwise.

We fabricated, continued fabricating, the tower in the spring of 1957, and in order to visualize what we had to contend with out on the site, we actually built a model, a template which, I think, this committee saw last week in the motion pictures we had made.

With this model we were able to visualize our problems in upending, also in being able to tell how it would react during the upending and we in turn made some changes to it, because of these experiences.

Finally, in the latter part of June 1957, we sailed with the template and platform for offshore New Jersey.

In connection with the lashing down of the diagonal braces in the three planes, we had suggested since this was a temporary lashing down, we submitted a drawing which, first was approved, and then, finally, just before we sailed, it was disapproved and changed.

We objected to this: in fact, we wrote a letter to that effect that we didn't think the lashing down, the securing of these braces in these three planes, was as secure as the suggested method that we had made, and so, as I say, indicated in a letter, a copy of which we have here.

Mr. KENDALL. Will you make that a part of the record, Mr. Rau, please?

Mr. RAU. Yes, sir; we will, Mr. Kendall.

(The document referred to follows:)

JANUARY 23, 1957.

OFFICER IN CHARGE OF CONSTRUCTION,
Texas Towers, Boston, Mass.

DEAR SIR: Today, we received from Moran, Proctor, Mueser & Rutledge S. & M.–K drawing No. 47, Rev. 1, CCS plan No. 3038–00–33, and CCS plan No. 3038–00–21. All these drawings contain notes or corrections which we consider beyond the requirements of our contract.

All of these drawings contained the following note: "For field welds to permanent bracing preheat prior to welding, and use low hydrogen electrodes. Postheat to 400° F." or words to that effect.

Insofar as known to us, this type of requirement is not required in NavDock Specifications 47142. Therefore, if this procedure is to be required, we request that you issue us a directive so that it may be considered as a modification to our contract. We do believe, however, that if this procedure is to be required that it will result in a delay in the fabrication and erection of Texas tower No. 4.

On CCS plan No. 3038–00–21 Texas tower No. 4 template bracing stowage at elevation minus 73.67, several corrections were indicated. This CCS plan is based on S. & M.–K drawing 43, Rev. 1, which was approved by Moran, Proctor, Mueser & Rutledge on July 24, 1956. The corrections indicated for the CCS plan modifies the S. & M.–K drawing. Furthermore, we feel that the changes now indicated by Moran, Proctor, Mueser & Rutledge will not give us as secure a structure as shown on S. & M.–K drawing 43, Rev. 1, which has already been approved. Also, these changes at this late date will result in a possible delay to our subcontractor Continental Copper & Steel Industries, Inc. We, therefore, request that you reconsider the corrections indicated to be made on CCS plan No. 3038–00–21 with the view of eliminating same.

Very truly yours,

STEERS & MORRISON-KNUDSEN,
By E. G. HERB,
Alternate Project Manager.

Mr. RAU. In order to assure ourselves that we were able to tow this template and to know what conditions we could do it under, we employed a consulting engineer to figure the stresses during tow, and it was determined, after consulting with the Navy and the architect-engineer that a 15-foot wave was the maximum wave that we wanted to tow this template in, and that 15-foot wave, as I remember, if my memory serves me right, would give us about 10,000 to 12,000 pounds stress, which is far under anything that would be allowable on this structure.

With the Weather Bureau at Logan Airport in Boston, Woods Hole, Floyd Bennett Field in Long Island, and the Navy weatherman here in Washington, we were able, every 4 hours, to get a reading on the weather, and after launching started towing it to the site.

We arrived at the site on the morning of July 4, 1957. At that time the template and the bracing were entirely intact.

Senator SYMINGTON. Would you mind defining the word "template" as you use it?

Mr. RAU. What we called the template are the three legs with the corresponding bracing, which included during the towing a 6-foot diameter buoyancy strut, which is not shown on this model.

After we anchored the platform, by that time it was practically noontime, we decided to prepare for upending the template.

However, due to the time it took us to make the preparations it became about dusk, and at that time the wind started to kick up, and the seas started to increase, and it was then decided to hold off the upending of the template until July 5, the next day.

During the night of July 4 and early morning of July 5, we had a fair amount of sea.

We kept the template under tow heading into the wind at all times to diminish any effects the weather may have on the template, but the following morning it was observed that one of the diagonal braces on the A–B side was broken off, and the other one was damaged.

DAMAGED BRACING DISCOVERED

Senator SYMINGTON. Would you mark that; could you show us what that was that was broken?

Mr. RAU. That was these two braces here, one of which, I don't recall which one it was, was broken off, and the other one was damaged.

During the tow they were the ones folded down and secured to this horizontal brace at elevation of minus 75 feet, and this horizontal brace at minus 25 feet was secured down about elevation minus 50 feet, if I recall.

During July 5, the weather was still bad, and we couldn't think of upending the template.

It was during that time that I had a conversation with representatives of the Navy concerning these two diagonal braces as to what was to be done and what could be done.

It was pointed out in the conversation that there were only two ways of doing the work. One was taking it back to Portland, putting it back in drydock, and actually putting the braces back exactly as they had been when we left the yard a week or so before.

The other was to have a design made by a competent A. & E.——

Senator SYMINGTON. A competent what?

Mr. RAU. A. & E., architect-engineer, to install braces under the water.

It was also pointed out at that time by me if we did go back to Portland, which we would have had to do because it was the only drydock at that time anywhere in the vicinity that could handle a structure of this size, we would not be able to emplant the tower in 1957, but it would have to be held over until 1958.

It was then the decision—the decision was then made that we would go ahead with the upending and get a design for the installation of permanent braces underwater.

Senator SALTONSTALL. Mr. Chairman, would you permit the witness, Mr. Rau, to take that model and show us how it lay on these barges?

Mr. RAU. No, sir; it didn't lay on barges. It actually floated.

Senator STENNIS. Pardon me just a minute. I hope I am not too much wedded to our system, but the gentleman can testify directly as to just what occurred. I believe we can understand it better if we let him finish his story then go back and question him about any points that we have in mind, Senator.

Senator SALTONSTALL. I just wanted to understand a little better what he was talking about, but that is all right.

Senator STENNIS. All right, Mr. Rau, if you would rather clear up the question that the Senator has in mind you may do so.

Mr. RAU. Well, actually the template floated on the A–B legs in that position, and in upending, we flooded the buoyancy struts and then the compartments in the legs at certain intervals to upend it in this direction until we had finally had it upended completely in a vertical position, at which time the bottom of the legs were some 15 feet, if I recall rightly, above the bottom of the ocean.

It was then towed into position, and the last flooding valves opened, and it was sunk down to the ocean floor.

Senator SALTONSTALL. Which braces were broken?

Mr. RAU. It would have been these two braces that were partly submerged between the "A" and "B" legs, and between elevations minus 75 feet and minus 25 feet, these two.

Finally, the weather cleared on the morning of July 6, and we proceeded to upend the template.

It was at the beginning of this upending that the other brace, which I mentioned before was damaged the night of the 4th and the morning of the 5th, broke off completely and floated away.

We upended the template, and had it completely upended by late July 6, set it on the bottom of the ocean early Sunday morning, July 7, and brought the platform in that afternoon, securing it to the legs in the late afternoon, after which we fastened to the jacking system, the platform, we fastened the jacking system to it during that night, and started the next morning to jack the platform up on the legs.

A lot of the other procedures this committee, I know, has heard of, and we have seen it in the pictures you showed last week.

We completed the construction of this tower and turned it over to the Navy, I believe it was, in November or late 1957.

After inspecting, making an underwater inspection, to make sure the pins and everything were satisfactory, we turned it over to the Navy.

Senator STENNIS. Does that finish your statement?

Mr. RAU. Yes, sir; it does, Senator.

Senator STENNIS. I just have one or two questions, and then I will call on the other Senators. Some may have to leave, and we will let the Senators ask their questions, and then counsel can cover the other points.

You referred to the fact that you had completed the structure. Does that include the underwater repair that has been testified about?

Mr. RAU. It included the replacing of the broken diagonals on the A–B side.

Senator STENNIS. I think you ought to explain. Some Senators could not be here during all the hearings. We have had that explained before, but I think you, as the man in charge of construction

should explain just what was done in the underwater repair after the upending.

Mr. RAU. Right after the upending, we engaged the architect-engineer to make a design of these two braces, the architect-engineer being Moran, Proctor, Mueser & Rutledge, and as soon as we obtained a drawing we let a contract with Bethlehem Shipyard in Staten Island to fabricate these braces as quickly as possible so that we could get them in place.

As I recall, they came out sometime in August 1957, and the braces consisted of a height the same size as the original brace, pinned at the end the same way as the original brace.

The difference was, of course, here when it broke off it only left a stub against the leg, and there was no way of fastening it underwater, so this became a collar, two half sleeves, as it were, with flanges, that were bolted and pulled together, and fastened to the legs, and those were installed and, as I recall, from the records, completed in September 1957.

Senator STENNIS. What was your opinion, after this installation, as to the strength of the tower as compared with what it would have been had there been no loss of braces?

Mr. RAU. Well, we felt, with the competent architect engineers that were doing the work, Mr. Chairman, that it was a complete replacement of the initial diagonal bracing.

Senator STENNIS. That means that you thought it was restored to its original strength?

Mr. RAU. That is right, sir.

Senator STENNIS. And stability?

Mr. RAU. Yes, sir.

Senator STENNIS. All right.

Did that prove to be true or did this brace break again?

Mr. RAU. No, sir. The brace——

Senator STENNIS. Did the clamp or collar remain secure?

Mr. RAU. I was thinking of the time later, this last fall, that is why I hesitated.

No, in late 1958 it was reported to us that one of the clamps, I believe around B leg, I am not sure, it was around one of the legs, was loose, and the clamp was actually moving up and down.

Senator STENNIS. That is the clamp or collar that had been specially designed for the replacement of the braces?

Mr. RAU. That is correct, sir.

Senator STENNIS. All right.

What did you do then, or what was done—whether you did it or not?

Mr. RAU. It was then decided to replace these Dardelet bolts with T-headed bolts, and they were completely installed by June, 1959, and checked a number of times since then and found to be tight at all times.

Senator STENNIS. You heard the testimony of this gentleman this morning, Mr. Brewer, about the instrument tests that he made in the winter of 1958 and 1959?

Mr. RAU. Yes, sir; I did.

Senator STENNIS. What is your reaction to the matters developed by the use of his instruments?

Mr. RAU. Well, I am not familiar with his instruments, Mr. Chairman; no, sir.

Senator STENNIS. All right.

Mr. RAU. In fact, until this morning I didn't know such a test was made.

Senator STENNIS. One further question: When you were confronted with the situation of the broken braces, as I understand it, the alternative was to take it back to port or attempt to make the installation and repair underwater.

CONTRACTOR CLAIMS NAVY HAD TO MAKE DECISION ON WHERE TO REPAIR TEMPLATE

Now, whose decision was this? Yours, the Navy's, or the Air Force as to what should be done?

Mr. RAU. It would have to be the Navy's, Mr. Chairman.

Senator STENNIS. I beg pardon?

Mr. RAU. It would have to be the Navy's, Mr. Chairman.

Senator STENNIS. All right.

Mr. RAU. Because we would not be in a position to make such a decision.

Senator STENNIS. You were just the builder.

Mr. RAU. That is correct, sir.

Senator STENNIS. Yes.

Now, was the architect-engineer in any way involved in this decision?

Mr. RAU. The architect-engineer, Mr. Phil Rutledge, arrived on the site actually after the upending, which would be the night of July 6, 1957, at which time he was brought into the discussions.

Senator STENNIS. But the upending had already taken place. The decision had already been made, and you had upended the tower.

Mr. RAU. That is right, sir.

Senator STENNIS. So he was not involved in the decision?

Mr. RAU. No, sir.

Senator STENNIS. Did you make a recommendation as to which course would be taken; whether to go back to port or undertake the repair at sea?

Mr RAU. As I recall, I did not.

Senator STENNIS. You did not make any recommendation on that?

Mr. RAU. No, sir.

Senator STENNIS. Was your attitude then that you were at the service of the Navy and would abide by its final decision?

Mr. RAU. That is correct, sir.

Senator STENNIS. And you would follow the course that they suggested?

Mr. RAU. That is right, sir.

Senator STENNIS. Does that give a full picture to this committee of what happened?

Mr. RAU. I believe it does. I didn't go on with the other details because——

Senator STENNIS. I mean on that decision

Mr. RAU. Oh, yes, sir; yes, sir.

Senator STENNIS. Yes.

There was no difference of opinion then between those who discussed the matter as to what should be done?

Mr. RAU. No, sir; because I can assure you if the decision was to tow it back to Portland we would have done it because, after all, we had to complete the project to the satisfaction of the owners, in this case the Navy, and I could certainly not have made a decision to go ahead under an order to tow it back.

Senator STENNIS. I beg your pardon?

Mr. RAU. I could never have gone ahead with the decision of up-ending it against an order to tow it back.

Senator STENNIS. So it was entirely their responsibility and not yours?

Mr. RAU. That is right, sir.

Senator STENNIS. All right.

Senator Saltonstall?

Senator SALTONSTALL. Mr. Chairman, I have just a very few questions.

Senator STENNIS. Certainly.

Senator SALTONSTALL. First, let me ask you this question: After you turned this tower over to the Navy in November 1957, did you have anything more to do with it?

Mr. RAU. The next time we were out on the tower, Senator, as I recall, was in the spring of 1959.

Senator SALTONSTALL. But did you do any work on it?

Mr. RAU. We did work on it, as I say, in the spring of 1959, that was the next time I recall.

Senator SALTONSTALL. Under whose orders did you do that work?

Mr. RAU. That was under the Navy.

Senator SALTONSTALL. The Navy?

Mr. RAU. Yes, sir.

Senator SALTONSTALL. That was work outside of your contract?

INSTALLATION OF T-HEADED BOLTS

Mr. RAU. No, that was the installation of the T-headed bolts in place of the Dardelet bolts.

Senator SALTONSTALL. And that was done under part of your original contract?

Mr. RAU. We had been in conference with the Navy during the winter of 1958 or early 1959, I don't know the exact time, I think it was December of 1958, and it was mutually agreed we would supply the manpower to install these T-headed bolts as soon as the weather permitted.

METHOD OF SECURING THE LASHED-DOWN BRACES

Senator SALTONSTALL. Now, you said, if I understand your testimony correctly that you did not approve of the method of the lashing down of the braces for towing; is that correct?

Mr. RAU. We did not approve, Senator, of the change that was made to our suggested method of securing the braces.

Senator SALTONSTALL. What was your suggested method?

Mr. RAU. We wanted to weld—we had an angle frame over these braces folded down, and we wanted to weld it and make it a pretty

solid structure, and the decision was that after, from the letter that we have here evidently approving it, a decision was made not to permit the welding and we, in turn, had to bolt this angle frame.

Senator SALTONSTALL. Now, there has been a great deal of discussion——

Senator SYMINGTON. Will the Senator yield? Will the Senator ask who made that decision.

Senator SALTONSTALL. Senator Symington asked who made that decision.

Mr. RAU. Well, this is a letter dated January 23, 1957, to the officer in charge of construction, Texas towers, in Boston, and in this letter, this was signed by our alternate project manager, a Mr. Ed Herb, and he acknowledged receiving from Moran, Proctor, Mueser & Rutledge of a drawing, of our drawing No. 47, revised such and such—all of these drawings contain a notice of corrections which we considered beyond the requirements of the contract, and then he goes on to say down in the last paragraph:

"On Continental Copper & Steel's drawings," which they had made for us showing this holddown frame plan so and so, TT–4 template bracing stowage elevation minus 73–64, several corrections were indicated. "This CCS plan is based on S and M–K drawing 43 which was approved by Moran, Proctor, Mueser & Rutledge." This was on July 24, 1956.

"The corrections indicated for the CCS plan modifies the S and M–K drawing."

It was, to answer your question, Senator, it was made by the architect engineer, Moran, Proctor, Mueser & Rutledge.

Senator SALTONSTALL. I didn't hear that.

Mr. RAU. The corrections were made by the architect engineer, Moran, Proctor, Mueser & Rutledge.

Senator SYMINGTON. The question that I asked was who was responsible for not making the corrections in accordance with the recommendation of the producer, and the answer is the people who instructed them to do it differently than they thought was the better way of doing it, was the firm with the name ending in Rutledge.

Senator SALTONSTALL. Thank you. It was a firm then and not the Navy itself?

Mr. RAU. No, sir. This letter though objecting was addressed to the Navy.

Senator SALTONSTALL. There had been a great deal of discussion here about the relative merits of pins versus welds. Did you have anything to do with making the decision as to whether there should be pins on these braces or whether they should be welded?

Mr. RAU. We had nothing whatsoever to do with the original design, Senator.

Senator SALTONSTALL. So that your job was to carry out the design and construct the tower according to the designs that were given to you?

Mr. RAU. That is correct, sir.

Senator SALTONSTALL. And you made no recommendations or suggestions or anything else regarding those designs?

Mr. RAU. No, sir; we did not.

DAMAGE TO THE LEGS

Senator SALTONSTALL. Perhaps it is immaterial now, but one of the legs was severely dented through an accident. I don't recall exactly now just what the accident was. Do you recall what I mean?

Mr. RAU. Yes, sir; I do.

It was during the time the platform was brought into the template, and the 12 hours or so it took before we could actually raise it up on the template, all three legs were damaged to varying degrees. That, I think, is what you are referring to, sir.

Senator SALTONSTALL. Did that damage on those three legs weaken the tower in any way, in your opinion?

Mr. RAU. A correction or repair to the damage drawing was given to us by the Navy which entailed placing solid concrete inside these legs after we welded off H-beams and put in steel reinforcing. I say solid concrete. Actually we left a hole, as I recall, some 24 inches to leave access to get below, but I believe in that respect with all our concrete reinforcing in there, that it repaired that portion of the legs to its original strength.

Senator SALTONSTALL. So that would not cause any weakness of the tower in the future?

Mr. RAU. I don't believe so, sir.

Senator SALTONSTALL. Now, let me ask just one more question: Were you supervised in your construction as the work went on?

Mr. RAU. Yes, sir; we were.

Senator SALTONSTALL. By whom?

Mr. RAU. Well, the Navy had representatives on the job at all times. Of course, Commander Foster was out there at varying times, and he had a lieutenant whose name I don't recall now, and several—Lieutenant Poulos, and several civilians.

Senator SALTONSTALL. So that as the construction went along you were supervised and, to the best of your knowledge, you did the work satisfactorily?

Mr. RAU. Yes, sir.

I may add to that, as I recall, the Air Force had one warrant officer represented at all times.

Senator SALTONSTALL. Were any comments or suggestions made to you as you went along as to the strength of this tower?

Mr. RAU. No, sir. Having the designs coming from what we felt was a competent architect-engineering firm or joint venture firm, why, we did not feel we were qualified to make suggestions.

Senator SALTONSTALL. Thank you, Mr. Chairman.

Senator STENNIS. Senator Symington.

PLANS AND SPECIFICATIONS

Senator SYMINGTON. Mr. Rau, I am impressed with your testimony.

As I understand this, the Air Force wanted a tower built. They went to the Navy and the Navy got in touch with the Anderson firm and they with another firm. As a result, they were given an order, first a feasibility order, then a design order with money passing to the contractors. Also as a result, an order was given to you to build the tower. Is that correct?

Mr. RAU. That is right, sir.

Senator SYMINGTON. Who did you get that order from?

Mr. RAU. From the Bureau of Yards and Docks. It came out of the 1st Naval District in Boston.

Senator SYMINGTON. From the Bureau of Yards and Docks.

Did the Navy give you or tell you where to get the designs from which you were to build?

Mr. RAU. Well, this job was actually bid on competitively, Senator.

Senator SYMINGTON. Yes.

Mr. RAU. And the plans, the complete plans, were furnished each contractor who bid. There were, for tower No. 4, only two bids.

Senator SYMINGTON. Who drew up those plans?

Mr. RAU. A joint venture made up of Anderson-Nichols, and Moran, Proctor, Mueser & Rutledge.

Senator SYMINGTON. Those two firms drew the plans?

Mr. RAU. Yes, sir.

Senator SYMINGTON. And the Navy accepted the plans?

Mr. RAU. Evidently they did.

Senator SYMINGTON. Because they were the plans that the Navy asked you to bid against?

Mr. RAU. Yes, bid on; correct.

Senator SYMINGTON. Yes.

Now, you constructed the tower on the basis of those plans?

Mr. RAU. That is right, sir.

Senator SYMINGTON. Has there ever been any statement, verbal or written, that you did not construct them in accordance with those plans?

Mr. RAU. I don't know of any, sir.

Senator SYMINGTON. You know of no criticism of your execution of the design?

LETTER OF COMMENDATION

Mr. RAU. No, sir. In fact, at the completion of our project, which was the building of both Texas towers No. 3 and 4, we received a letter of commendation for our work.

Senator SYMINGTON. You did receive a letter of commendation?

Mr. RAU. Yes, sir.

Senator SYMINGTON. After you built the tower then you lugged it down by sea to where you were going to install it; is that correct?

Mr. RAU. That is right, Senator.

Senator SYMINGTON. Did you make any mistake in bringing it down that you know of?

Mr. RAU. No, sir; because, as I mentioned before, when we arrived on site, why, the template and platform were intact.

Senator SYMINGTON. You put it up?

Mr. RAU. That is right, sir.

Senator SYMINGTON. Was there anybody from the Navy there at the time?

Mr. RAU. Oh, yes, sir; in fact, during the upending of the template, Commander Foster was actually in the control house, as we call it, on the template.

Senator SYMINGTON. Did you direct the upending, your firm, or did he?

Mr. Rau. No, sir; we did.

Senator Symington. You did?

Mr. Rau. Yes, sir.

Senator Symington. Did he object at any time to the way you did it?

Mr. Rau. No, sir. I do not know of any objection.

Senator Symington. Then, at a certain time you had completed the work of locating the tower, is that correct?

Mr. Rau. That is right, sir.

Senator Symington. When did you find that the tower was broken?

Mr. Rau. Do you mean when did we first know that any braces were broken, Senator?

Senator Symington. That is right.

Mr. Rau. The first indication of any braces being broken was in our inspection after Donna last October 1960.

Senator Symington. But you did not know of any failure at the time that you upended the tower?

Mr. Rau. Oh, I am sorry. We, as I explained before, during the night of July 4 and the morning of July 5, the two braces folded over on the A–B side, at elevation minus 75 feet were damaged; one, in fact, was broken off, and the other was damaged, I am sorry.

Senator Symington. That, I thought was your previous testimony.

Mr. Rau. That is right, sir. I didn't understand it.

Senator Symington. Was that at the time of the original installation?

Mr. Rau. That is right, sir.

Senator Symington. Why did they break off?

Mr. Rau. We had quite a severe storm that evening of July 4 and early July 5, and in fact, it was so severe that some of the gentlemen, Mr. Steers here and Mr. Rutledge who were coming out on Mr. Anderson's yacht, never were able to get out of Patchogue, Long Island, and they finally had to go back and they came back on our boat from Fall River on the 6th, Mr. Steers did.

Senator Symington. Was the storm one—this is a surmise, but I think it a fair question—was the storm one which you feel was greater than the people who designed the tower felt any storm would ever be?

Mr. Rau. Well, Senator, of course, the storm which you are referring to was the storm that hit us while the template was in floatation prior to upending.

If you are referring to the design criteria that were set up by the architect engineer for after the template or platform was in place, they are two different things.

Senator Symington. I understand. But my point is that in an effort to locate responsibility, was the design basically at fault or was the fact that you decided, regardless of the storm and with the approval of the Navy, to put it up on that day or night or 2 days and 2 nights, what was the primary reason for the breakage of the tower?

Mr. Rau. Well, the primary reason for the breakage of those two diagonal braces on the night or early morning of the 4th and 5th of July, was due to the successive storms and, of course, we were out there some 85 miles from the Jersey coast, and there was just no place to run; we just had to ride it out, and that is what we did, to the best of our ability.

Senator SYMINGTON. If you had had it installed before the storm came up, do you think you would have had any of this trouble?

Mr. RAU. Well, I will say this, Senator: If we had installed it on July 4 when we started to upend or started the preliminary operations which we were hoping would upend it, and were not hit with a storm on the night of the 4th, we wouldn't have had the trouble of losing the braces and having to replace them.

Senator SYMINGTON. When you saw that it was wrong, weren't there discussions as to whether you should take it back to port or whether you should try to fix it there? Wasn't there any discussion of that?

Mr. RAU. Yes, sir; there was.

Senator SYMINGTON. Tell us about that. Who discussed it?

Mr. RAU. Well, I discussed it with Commander Foster.

Senator SYMINTON. What did he say?

Mr. RAU. As I recall, and I checked these with some of the men who were present at the time and in the discussion, that it was finally decided that we would upend, and that a design of two diagonal braces to be installed underwater would be made.

Senator SYMINGTON. Who made that decision?

Mr. RAU. As I recall, it was granted by the Navy. The decision was given to me by Commander Foster. Whether he made it or made calls or something, I don't know.

Senator SYMINGTON. Did you feel at the time that it was the right decision?

REPAIR AT SEA DEEMED THE CORRECT DECISION

Mr. RAU. Well, sir, being out there in 1957 knowing the urgency of getting the job done so that it would be put into the chain of national defense, I think we felt it was the right decision; yes, sir.

Senator SYMINGTON. I think that is a good answer.

The warrant officer of the Air Force, was he present at this decision?

Mr. RAU. I don't recall whether he was present at this particular decision or discussion.

He was more put on there by the Air Force to observe. I don't recall his ever getting into discussing decisions or giving any decision. I think he was just there for observation purposes and to familiarize himself with the operation of the towers so that when the Air Force took it over he would know what it was all about.

Senator SYMINGTON. Did you have any relationship in the construction of this tower with anybody in the Air Force from a contractual standpoint or——

Mr. RAU. Until last June of 1960 we never had any relationship with the Air Force contractually.

Senator SYMINGTON. What was your relationship last June?

Mr. RAU. Well, last June or actually, I think it was—may I refer to some notes—actually some time in the latter part of May the Air Force contacted us and told us that they wanted to install braces above water and do some other incidental work.

We, in turn, sat down with them and went over the work that they wanted done, and finally we received a contract from the Air Force on June 3, 1960, for performance work.

Senator SYMINGTON. Why did they want to do this additional work?

Mr. RAU. Well, they said there had been, as I recall, a lot of motion in the tower, and they wanted this bracing above water installed to stiffen the tower.

Senator SYMINGTON. I would like to ask a question, just as a layman. We have heard a lot about motion. As I understand it, the Empire State Building moves a couple of feet in the wind so the question implies relative motion, does it not?

Mr. RAU. That is right, sir.

Senator SYMINGTON. And they thought that was dangerous?

Mr. RAU. Well, it may have been a fact that was more mental or they thought it was more mental for the boys aboard having this motion all the time rather than serious to the structure itself.

Senator SYMINGTON. Did you feel at that time it was a danger to the lives of the men aboard?

Mr. RAU. No, sir; I did not.

Senator SYMINGTON. Did you ever at any time feel it until it fell?

Mr. RAU. I felt that it was in a weakened condition in January of 1961; yes, sir.

Senator SYMINGTON. And at that time what did you suggest?

Mr. RAU. Well, if I may, Senator——

Senator SYMINGTON. Let me rephrase my question to ask it this way; what happened between June 1960 and January 1961 to make you feel that there was danger in this setup?

Mr. RAU. Well, we received this contract, if I may start from June?

Senator SYMINGTON. Yes, sir.

Mr. RAU. We received this contract on June 3 from the Air Force to, as I mentioned, to install these braces above water, to make under water inspections of the pins to test and tighten collar bolts, if necessary, at elevation minus 65 feet; to test the K-brace bolts which connect the main legs to the platform, magnaflux the welds connecting the K-braces, which is a method of checking welds to see if there are cracks actually in the weld which cannot be seen by naked eye.

Then, in August, July and August, we had addendum to this contract to do some additional miscellaneous work.

We completed that work in the first part of August, and we removed our men, I think it was, August 10.

Of course, Hurricane Donna struck on September 12, and soon thereafter we were contacted again to first replace the maintenance scaffold which was almost completely carried away during Donna, and to do some more investigating of the welds on these braces above the water to see if there were any cracks in them, and also to inspect the braces underwater.

We went out—in that contract, incidentally, there was also an item called item four, which required us to inspect, do this inspecting, and report our findings with pictures and all.

CONTRACTOR ASKED TO EVALUATE TOWER'S REMAINING STRENGTH

At the bottom of the last part of this item it required us to make a report or to have our report include a statement concerning the

tower's structural capacity or incapacity to withstand future storm conditions within the tolerances set by the original design criteria.

I pointed out at that time to the Air Force, and this was, maybe the first or second of October 1960, that we did not have the capability of making such a report, and I requested permission to call in Moran, Proctor, Mueser & Rutledge, which permission was given us; in fact, an addendum came through on October 21 stating that we would call them in.

I called Mr. Carlton Proctor on October 3, and told him about this requirement, and asked him if he would do this for us, giving us a price, and I sent him the addendum, marking out the item I was talking about, a copy of which, incidentally, I have here, and that was a report that he was to make for us.

We completed this work in the middle of November 1960.

During this inspection we found one of the diagonal braces between elevation minus 75 feet and minus 25 feet broken.

The Air Force then asked what could be done as far as repairing it at all, and we, in turn, called in—they may have talked to Moran, Proctor, Mueser & Rutledge directly, I don't know, but I know I talked to them, and on the 22d of November we had a meeting in our office with the Air Force, and Mr. Carlton Proctor, Mr. Phil Rutledge, and Mr. Ted Kuss were present and they gave suggestions as to how they would repair the tower.

Senator Symington. At that time was the question of danger a question that came up?

Mr. Rau. No, sir; it was not. Of course, we knew the tower was weakened, but the question of danger was not mentioned.

Senator Symington. Did anybody think about it? Did you think about it? At that point were you getting nervous about the men on the tower?

Mr. Rau. Well, trying to go back 6 months, Senator, and recall, I would say that since the hurricane season had passed, the weakened condition wasn't exaggerated as much as it would be if it were, say, August rather than November, December.

Senator Symington. You were in and out of this year after year. At some point the question of weakening became a question of danger. I was wondering inasmuch as you were the builder and knew the plans—I say this without any implied criticism—what was the time when you came to the belief, if not to the conviction, that something ought to be done quickly, or these men would be in danger?

Mr. Rau. Well, we knew when this meeting was held on the 22d of November that we had so much work to do; we pointed out to them at that time how long it would take us to do it. We had figured on completing the job by about the first of March 1961, and we then proceded with that work.

DANGER BECOMES APPARENT

It wasn't until January 8 when the brace between minus 175 feet and minus 125 feet was reported to me as broken that we became more alarmed.

Senator Symington. Then what did you do?

Mr. RAU. Well, if I may just transverse to the day before, our divers, in preparing to put in these cable braces went down to move out the hydrostatic cable, and found this one brace broken.

By the time they came up it was late Saturday night, and the report was not phoned in to us until early Sunday morning, in fact it was phoned in to one of my engineers who called me about a quarter of nine Sunday morning on January 8.

I told him immediately to call the architect-engineer who, in this case, was Ted Kuss, because he knew Ted Kuss' home phone, and report the findings to him.

Senator SYMINGTON. And then?

Senator STENNIS. Pardon me just a minute, gentlemen. What date is this now? You have given the day of the week.

Mr. RAU. This is Sunday, January 8, sir.

Senator STENNIS. All right.

Mr. RAU. That the conversation—it was actually found on Saturday, January 7.

Senator STENNIS. Very well, proceed.

Mr. RAU. It was January 8 that we had this conversation, or these conversations.

Mr. Kuss asked my engineer if there was any other damage found, and he said he had not talked to the tower directly, why, he said, he didn't know, but he would call the tower immediately and call him back, which he did.

And it was reported back to him that, to their knowledge there was no other damage found by the divers the day before.

He talked to Mr. Kuss again later in the day and conveyed the information to me by phone, asked me—if I may read his telephone conversations, I think it would be better than my——

Senator SYMINGTON. Could you put it in the record?

Mr. RAU. Yes, sir. I would.

Senator SYMINGTON. The nub of it was what?

Mr. RAU. Well, he asked about these diagonal braces, whether this new break would change the idea of these braces; whether, in turn, this one should be lowered down to minus 175 feet to take care of this other panel, and it was at that time that Kuss said, no, he didn't think that would be the right thing to do.

Senator SYMINGTON. What firm is he with again?

Mr. RAU. Moran, Proctor, Mueser, & Rutledge.

Senator SYMINGTON. You had a meeting on the 12th, didn't you?

Mr. RAU. Yes, sir. Well, all that week we were in contact with Ted Kuss; our engineer Bob Koch was actually talking to him and conveyed all the information to me, talking about the capability of the tower as it now stands.

Senator SYMINGTON. Did the Rutledge company send anybody down to the job during this time?

Mr. RAU. No, sir.

Senator SYMINGTON. So that it was all on the phone or in writing or in person without going and looking at it; is that right?

Mr. RAU. Actually it was all on the phone or in person.

Senator SYMINGTON. Yes. Where was the meeting on the 12th of January?

Mr. RAU. It was in my office.

Senator SYMINGTON. In your office?

Mr. RAU. Yes, sir.

Senator SYMINGTON. At that time was Mr. Kuss there, too, at that time?

Mr. RAU. Yes, sir. Well, to start with, the morning of the 12th, after we asked almost every day from the 8th to the 12th the capabilities of the tower, and all, our Mr. Koch talked with Mr. Kuss, along about 10 o'clock on the 12th——

Senator SYMINGTON. Ten o'clock in the morning?

Mr. RAU. In the morning; yes, sir. It was that time that Mr. Kuss indicated this 55-percent capacity after the wire bracing was in place.

PERCENTAGE OF TOWER'S REMAINING STRENGTH GIVEN

When Mr. Koch gave me that information, as soon as he got off the phone, why, I sat down and discussed it for a few minutes, and I told him that I had been thinking of the tower all week, and that since we were having that meeting this morning at 11 o'clock, that is, on January 12, that I was going to recommend evacuation.

I called Mr. Kuss up myself and asked him exactly what he meant by 55 percent.

Senator SYMINGTON. You say you told them; who did you tell before you called Mr. Kuss?

Mr. RAU. About evacuation or recommending evacuation?

Senator SYMINGTON. You said you told them.

Mr. RAU. Well, I was talking to our engineer Bob Koch, and Mr. Steers actually stopped in my office, and I told him then that I thought we should recommend evacuation.

Senator STENNIS. All right, pardon me just a minute there. I don't know that the witness has understood about our situation. For reasons we don't need to repeat now, we have agreed that we would not go beyond the conferences of January 12, in this hearing. I want to apprise you of that now so that you may understand it.

Mr. RAU. Yes, sir; I do.

Senator SYMINGTON. Mr. Chairman, I understand that. But I do think it is in order to ask the witness if he recommended evacuation. He built it. We haven't asked to whom he recommended—what I am trying to find out is the relationship between the Government contractor, the designer, and the producer.

Senator STENNIS. Pardon me, the Chair has ruled with you. The question was asked properly, and I think answered, and that is what I wanted to apprise the witness of.

Senator SYMINGTON. I have never seen Mr. Rau before in my life, to the best of my recollection. But the testimony shows that he was in contact daily with the designer by phone, and the designer never went down and looked at it; that at a certain point as a result of what the designer told him about the percentage from the structural aspect, he decided he would recommend evacuation of the tower.

Senator STENNIS. That is in the testimony; that is what he testified to.

Senator SYMINGTON. Thank you, Mr. Chairman. I have no further questions.

Senator STENNIS. I think that is the proper cutoff point, and I think that testimony is very relevant.

Just one minute more now. Going back, Mr. Rau, you certainly know the facts in this case, and you say that you had completed a certain amount of construction there, as I recall, sometime in November 1960.

Did you say that you finished some construction at the time?

Mr. RAU. We actually finished a change order to our initial contract on about November 13, 1960.

Senator STENNIS. 1960.

Now, you said that in November 1960, you knew of one broken brace, and then in January 1961 you found there was an additional broken brace; is that correct?

Mr. RAU. That is right, sir.

Senator STENNIS. I beg pardon?

Mr. RAU. That is right.

Senator STENNIS. Two broken braces.

You said that after this second broken brace was found, in your conversations, you gentlemen talked about doing something, but that nothing was said about danger or anything of that kind. Why were you having these conferences if you didn't think there was some danger?

Mr. RAU. Are you referring, Mr. Chairman, to January or are you——

Senator STENNIS. Yes. The January conferences after you found this second broken brace. You have testified about having conferences even prior to January 12, and you have covered these in detail. What were you conferring about on January 12 if it wasn't dangerous?

Mr. RAU. Well, we recognized that the tower was in a weakened condition.

Senator STENNIS. Yes.

Mr. RAU. And that we didn't believe it would withstand a hurricane or any extreme, very extreme, storms; in fact, on the 12th of January I requested from the Air Force the weather reports.

Senator STENNIS. Yes. I think you have fully covered the situation on January 12; that is very clear.

But what I am asking you is why were you having these conferences after you found the second broken brace if it wasn't about the danger that was involved?

Mr. RAU. Well, there was definitely an amount of danger.

Senator STENNIS. Yes. That is very obvious, isn't it?

Mr. RAU. That is right, sir.

Senator STENNIS. You say that the tower was in a weakened condition, but still no one discussed the possibility of danger yet. I haven't heard any other reason given for the conference except that a dangerous situation existed, and something had to be done about it. That was the situation, wasn't it?

Mr. RAU. That is right, sir.

Senator STENNIS. Yes.

Now, I never have called upon one witness to pass on another witness' testimony. Unfortunately, however, we have such a direct conflict in evidence here, that I think I owe it to you to read to you a portion of the former testimony. This is no suggestion that you are wrong in your testimony but I do think we should point out the area

of conflict upon the question of whether the tower should have been returned to port for repairs.

When Commander Foster testified earlier this week, the question arose during his examination by Mr. Kendall of who made the decision to make the repairs at sea after this defect developed in the tower. Mr. Kendall asked the following question of Commander Foster:

The vital decision, then, was whether or not to attempt repairs at sea underwater or return to port. That was the question; right?

Commander FOSTER. I would say that would be a fair statement of it, sir; yes.

Mr. KENDALL. Who ultimately made the decision to attempt to make the repairs at sea?

Commander FOSTER. I would like to refer again to my statement, sir, that this tower was not, at that time, the property of the Navy, nor was it the responsibility of the Navy. This tower belonged to the contractor, and would belong to him until such time as he turned it over to us in an acceptable condition. And if the contractor or any of his representatives felt that, (1) it was unsafe at the time, or, (2) he would be unable to make a successful repair at sea, it was up to him to take the tower back, not up to me to tell him to.

Now, further:

I did not consider it to be unsafe at the time, nor did I consider that we could not put in a successful brace. My statement was that I took no action to stopping or moving one way or another. This was his baby.

Mr. Kendall said:

My question was, Commander, specifically, who made the decision to attempt the repairs at sea?

Commander FOSTER. I approved the belief, if you like, that a repair could be successfully made at sea. I believed it then, I believe it now.

As to the decision, had the contractor had any doubt in his mind, it was his move. I took my action only based on the fact that he thought it could be done, our architect-engineer thought it could be done; I, myself, thought it could be done. So I allowed them to stay and go on with the process.

As I say, I thought I owed it to you to read that testimony. I don't know just how vital, in view of all the testimony considered together, this matter of responsibility for the decision will be, but you can see it is a highly important one.

And, as I understand it, you stand on the fact, and it is your testimony squarely, that you did not make the decision and that it was not your responsibility; is that correct?

Mr. RAU. Mr. Chairman, I gave the testimony as I remember it; yes, sir.

Senator STENNIS. All right.

Mr. RAU. Being it was our responsibility to upend the template, that is true. But it was also our responsibility to turn over to the Navy a structure that they would accept——

Senator STENNIS. Yes.

Mr. RAU (continuing). Before we had final payment. So I couldn't very well have made a decision to upend with the idea that in the end, come November or whatever it was when we completed the tower, that the tower wouldn't be accepted.

Senator STENNIS. At that point you were ready to follow either course that the Navy decided upon, and either go back to port or attempt the repairs at sea.

Mr. RAU. Under the circumstances we would have to be.

TOWER AT 55 PERCENT OF DESIGN STRENGTH

Senator STENNIS. All right, I think you made that clear.

Now, as I understood it, the estimate was made on January 12, that under the conditions then existing the tower was only 55 percent as strong as its original of design strength.

Mr. RAU. That is right.

Senator STENNIS. Is that right?

Mr. RAU. And that was the information I received at 10 o'clock in the morning of January 12.

Senator STENNIS. Who was the gentleman who made that estimate, and what was his affiliation?

Mr. RAU. Mr. Ted Kuss, a member of the firm of Moran, Proctor, Mueser, & Rutledge.

Senator STENNIS. All right.

Mr. Counsel, do you have additional questions?

Mr. KENDALL. I have one or two, Mr. Chairman.

As I understand it, Mr. Rau, the 55 percent estimate of the original capability was on the assumption that the cable bracing had been installed?

Mr. RAU. That is right, Mr. Kendall.

I would like to make one thing clear here. After receiving this information, as I started to say to Senator Symington before, I called Mr. Kuss up and asked him exactly what he meant by 55 percent, whether that 55 percent was 55 percent of the 125-mile-an-hour wind, which was the original criterion, and 55 percent of 35-foot waves or exactly what it was, and he explained to me then, which I knew and I just wanted explained by him, that the stress on the tower due to wind and wave action is in proportion to the square, so that actually it is not directly proportional, as I had put it.

Instead of being 55 percent of the original design criteria, maybe 80 or 85 percent. He didn't know the exact figure, but promised to get it for me.

Mr. KENDALL. The point I have in mind is that when he made that statement he was not saying that at that time the tower was 55 percent as strong as its original design strength. He was saying that when these repairs have been completed some time in the future it will then be 55 percent as strong.

Mr. RAU. When the cable, diagonal cable, bracing was installed; yes, sir.

Senator STENNIS. Any further questions?

Mr. KENDALL. Yes, Mr. Chairman.

Do you recall, Mr. Rau, what the criteria was for wind and waves during the tow?

Mr. RAU. I assume you are referring to the towing of the template?

Mr. KENDALL. Yes, sir.

Mr. RAU. We employed a consulting engineer to figure what the criteria should be during the tow, and he came up with 15-foot waves at a maximum, which would stress the members between 10,000 and 12,000 pounds per square inch, which is, of course, far below the allowable stress on the members, and this was submitted to the Navy and approved by them.

Mr. KENDALL. That was in combination with a 50-mile-per-hour wind, I believe; is that right?

Mr. RAU. I don't remember the velocity of the wind. I do remember definitely though that the 15-foot waves——

Mr. KENDALL. Did the storm which you encountered while at sea exceed that criteria?

Mr. RAU. The storm that we encountered at the site after arriving, I do not believe it did exceed the criteria; no, sir.

Mr. KENDALL. One final question, Mr. Rau. When the loss of the bracing was discovered, and you had these discussions, did not you or your firm have some opinion or recommendation as to what should be done as to whether or not it should be taken back to port?

Mr. RAU. Well, as I mentioned before, Mr. Kendall, the tower, as we understood it, was something to be erected and put into the national defense, the early warning radar system, and therefore such a decision had to be weighed as to how important it was for defense.

Mr. KENDALL. You were not operating in a vacuum out there. This was the situation that was confronting you, and you participated in the discussions, and certainly you must have had and expressed an opinion as to whether this was the preferable thing to do or whether it was preferable to take it back to port.

Mr. RAU. Well it is hard for me to remember now exactly how I felt. But, thinking now as I should have been thinking then, whether I did or not I don't know, I would say the decision of upending it and putting the braces in underwater was the decision that should have been made.

Mr. KENDALL. Do you think that was a sound decision under the circumstances?

Mr. RAU. That is right, sir.

Mr. KENDALL. Under the circumstances confronting you at that time?

Mr. RAU. Yes, sir.

Mr. KENDALL. That is all I have, Mr. Chairman.

Senator STENNIS. Let me see if Mr. French has some questions.

Mr. FRENCH. Yes, sir; I have.

Senator STENNIS. All right, Mr. French, you have some questions.

AGREEMENT OF DESIGN ENGINEERS TO EVALUATE TOWER'S REMAINING STRENGTH

Mr. FRENCH. Under item 4 of the contract, Mr. Rau, I believe the design engineers were to come up with new wind and wave criteria for the tower; is that correct?

Mr. RAU. That is correct, Mr. French.

Mr. FRENCH. At what point in time did they agree to perform this particular work?

Mr. RAU. I contacted Mr. Carlton Proctor on either the 2d or the 3d of October, telling him about such an item in the specifications, and asked him if he would cover it for us, and also asking for a price to do the work, and on the 3d of October we actually sent him a note indicating what was required.

Within a week after that I talked to him about the work and he agreed on doing the job for us.

Mr. FRENCH. Did you ever receive any written confirmation of the agreement to perform this work?

Mr. RAU. We did not receive a written agreement until January 4, 1961.

Mr. FRENCH. Would you make that a part of the record, please, sir?

Mr. RAU. Yes.

Mr. FRENCH. Have you ever received a report in accordance with the function which the design engineer was supposed to perform under item 4?

Mr. RAU. No, sir; we did not.

Mr. FRENCH. I have no more questions, Mr. Chairman.

Senator STENNIS. Thank you, Mr. Rau.

Is there anything else you want to say on any point, upon which you think elaboration is required? We always like to give the witness a chance to discuss any point he may desire to cover after his questioning has been completed.

Mr. RAU. On just a couple of Mr. French's questions there, the lateness of the letter confirming this conversation I had with Mr. Carlton Proctor back in October, October 3, we had worked with this firm on a number of occasions, and a lot of our work is done verbally, and confirmation is just a matter of record, and when it comes in, why, it comes in, and it is a part of the record. So that the timelag there had nothing to do with any lag in preparing the report.

Mr. FRENCH. I understand, sir. I wanted the date on which he agreed to perform the work.

Senator STENNIS. Thank you.

I want to say this to you, sir, it seems to me that you and your company were confronted with a very difficult task. We appreciate the fact that you have come here with refreshing frankness and willingness to tell this thing just as you saw it at each step and as the events unfolded. Everything considered, and as I understand the facts, it does not appear to me that there is anything about that which was done which should reflect on your construction or your ability to do a very difficult task.

Mr. RAU. Thank you, Mr. Chairman.

(The documents previously referred to follow:)

MEMO OF MAIN TELEPHONE CONVERSATION BY R. C. KOCH RELATIVE TO TT–4, JANUARY 8–15, 1961

SUNDAY, JANUARY 8

8:25 a.m.: Received call from Dick Tower stating that V. Yavorosky had called him from TT–4 and notified him that the divers during one of their dives on Saturday had found that the diagonal brace from —125 to —175 toward B leg on the AB side had broken at the pin plates on the upper end of the brace at the end of the pipe. Also, there were 4- and 8-inch-long circumferential cracks in the pipe at the end of the shell adapter plates on the above-water X bracing in the AB plane, at the upper connection at A leg.

8:35 a.m.: I called Mr. Rau with this information and then Mr. Kuss of M.P.M. & R. at his home. I gave Mr. Kuss the above information and asked him what this meant with reference to the tower. He replied that offhand it didn't seem good but that he couldn't say exactly at this point since it was very complicated. He asked if there were any further breaks or if these were the only ones. I answered that these were the only ones reported to me but that I would contact the tower myself to make sure, and to talk with V. Yavorosky and tell him to have the divers make a further inspection. Also discussed briefly with

Mr. Kuss the need for and possibility of making repairs to the diagonal braces as well as revising the wire rope bracing system to take care of this. He felt that a complete picture of conditions was necessary before a decision could be made.

8:45 a.m.: Called Dick Tower at home to let him know that I had talked to Mr. Rau and Mr. Kuss. We discussed the practicality depending on what the designers decided, of what might be done to repair the brace such as a collar of some sort, replacing it entirely, or altering the wire rope bracing somehow.

9:00 a.m.: Contacted V. Yavorosky on the tower and he confirmed the broken brace and cracks in the X-bracing as given to me previously. I then asked him to repair all cracks in the above-water bracing as soon as possible and to have the divers make a further inspection as soon as possible to determine if there was other damage. He replied that he would do this but didn't think that the divers could get in the water that day. I asked V. Yavorosky how the tower was acting and he said it seemed fairly steady. I asked him when he thought the break had occurred and he said he thought within the last month.

9:35 a.m.: Talked to Henry Schutz at home in Teaneck, N.J., to advise him of the information that had been given to me. We discussed the possibility and practicality of repairing the broken diagonal at this time in the event that M.P.M. & R. felt it necessary to do so. He thought that some sort of a collar could be put on at —125. We talked of the time it would take to do this type work at the site at that depth. Henry felt that it would be a long job at this time of year since diving time at that depth was quite limited and diving weather poor. Also, a diver required decompression time on the way up and if the wind and waves increased suddenly it could be dangerous getting him out of the water. We also discussed the possibility of doing the work if the designers lowered the bottom connection of the wire rope. Henry did not feel it practical to work productively at depths over 130 feet approximately. It also was not known how the leg could be filled below —146 if it was necessary to do so.

10:20 a.m.: Called Mr. Kuss of M.P.M. & R. at home. Advised him that I had contacted the tower and that the information I had given him originally was what we knew at the time. I ask him what we should do now—whether we should stop or continue or if it was necessary for the wire rope bracing to be redesigned, put at a lower elevation, or something else done to make allowance for the broken diagonal at —125. Mr. Kuss said that he had been doing some thinking about this since I had called him earlier and that the situation was probably not what he had first thought and that we should try to install the wire rope bracing as designed as quickly as possible. I said that this was not an operation that would take a week or two, but that we would certainly try, as we had been, to do it as quickly as possible. I asked him if we should bring the fill materials out to the tower as we had planned. He said that he thought we should go ahead with this and all work. He pointed out that if the horizontal brace at —125 was not broken that he thought the wire rope bracing system would be effective since he thought the legs would be quite stiff from —185 to —125 even without the diagonal brace. Mr. Kuss asked when the vertical pipe struts would be ready, and I said that the first one would be ready on the next weekend and the second one approximately 4 days later for transportation to the tower—weather permitting towing and installation. I said that we would inspect underwater as soon as possible to try to determine if there was further damage and that I would let him know as soon as we knew anything. I said that Steers—and I knew that the Air Force would too—would like to know what this broken diagonal meant with reference to the structural capacity of the tower. I asked that he look into this and let us know as soon as possible.

10:43 a.m.: Informed Henry Schutz of my last conversation with Mr. Kuss.

10:51 a.m.: Told Dick Tower of my latest conversation with Mr. Kuss.

11:30 a.m. (approximate): CWO Hardy of 4604th SUPRON at Otis called and asked if we had the information about the broken diagonal at —125 and if we still wanted the AKL–17 boat at our Jersey City yard the first part of the week to load the fill materials. I told him of my conversation with Mr. Kuss and that, with Air Force approval, we would follow Mr. Kuss' suggestion and continue as planned and at the same time make an underwater inspection to try to determine if there was further damage. He said that this procedure seemed to make sense and that the boat would be at our yard the first part of the week with the exact time still to be set.

1:30 p.m.: Talked with Mr. Rau of my latest conversation with Mr. Kuss and CWO Hardy.

MONDAY, JANUARY 9

Morning: Received a call from Mr. Ciccio and Colonel Battison from 26th Air Division, Syracuse, relative to information about the broken brace. I passed on what information I had and what the plans were. Mr. Ciccio replied that this approach seemed very logical. They asked what precautions had been taken relative to the tower. I replied that I understood from CWO Hardy that the commanding officer on board had authority to call the Coast Guard and/or the Air Force for boats or "choppers" at any time he deemed it necessary. For further information or details I suggested that they contact Otis AFB although I would try to find out myself.

Morning: Called Mr. Kuss of M.P.M. & R. to follow up request for information on tower condition with broken diagonal brace. He said it was quite complicated and that he was putting a man on it right away. I also advised him that we were going ahead with getting fill materials to the tower, as he had suggested. He approved and asked if we had any further reports from the divers. I said that we had not but would inform him as soon as we received such information.

Afternoon: Talked with CWO Hardy relative to boat arrival at Steers' Jersey City yard, and also asked him about question of precautions on tower for evacuation if necessary as asked by Mr. Ciccio. He confirmed that the commanding officer had authorization to contact Coast Guard or Air Force for help at any time. He suggested that Mr. Ciccio call Otis if they required further details.

Afternoon: Called Mr. Ciccio at Syracuse but talked to Colonel Battison who was in at time. Repeated conversation with CWO Hardy to him. Also suggested that he call Otis for additional information direct.

TUESDAY, JANUARY 10

11 a.m. (approximate): Received a call from V. Yavorosky on the tower stating that the divers had been down and had made an inspection of the brace at —125 on AB side and found no further damage on the horizontal brace, the other diagonal brace, or the legs at the end of the horizontal brace. They also rechecked the collar at —75 and it was solid, no movement, and no bolts loose. Tower appeared to be quiet. I told him to continue underwater inspection and to investigate as many areas as possible including cleaning legs and braces at connections for inspection.

11:30 a.m. (approximate): Called Mr. Kuss of M.P.M. & R. to advise him of my conversation with V. Yavorosky and to apprise him of the divers' findings. Mr. Kuss said that he had a man making calculations and would advise us as soon as they were complete. He also said he had his soil experts investigating the possibility and effectiveness of a rock berm at the legs because of the broken lower diagonal brace.

THURSDAY, JANUARY 12

9:30 a.m. (approximate): Mr. Kuss of M.P.M. & R. called to say that they had finished some of their calculations and the tower when the wire rope bracing was installed would be good for approximately 55 percent of the design criteria. He said that they were still investigating the possibility of rockfill around the legs. I immediately reported this conversation to Mr. Rau.

5 p.m. (approximate): Called Henry Schutz on the tower to report results of meeting held in our offices with Air Force and M.P.M. & R. Advised him that it was agreed that we would do certain work while the Air Force was winterizing their equipment and removing other equipment, as follows: (1) Divers to conduct underwater inspection, (2) repair and reinforce all cracks in above water bracing, (3) complete installation of vertical shear plates at center vertex (AB side); (4) place fill materials presently on tower in legs and grout B leg as shown on M.P.M. & R. drawings. Also told him of the 55 percent as given by M.P.M. & R. Henry informed me that they had gotten approximately 4,000 bags of fill material on tower and had installed about 25 percent of it in B leg.

FRIDAY, JANUARY 13

5 p.m. (approximately): Talked with Henry Schutz on tower. He informed me that they had been diving but had nothing new to report. Said that he and Captain Phelan were wondering if it was essential to bring the grout materials and mixer out at that time and if they could forego this part of the operation

70733—61——16

for now. I talked to Mr. Rau about this and it was decided that this grouting could be put off until the spring. I so informed Henry. I asked him how the tower was behaving and he said very well and had been since the clamp was installed at —75.

SUNDAY, JANUARY 15

4:40 p.m.: Received call from Henry Schutz on the tower. He had been trying to get in touch with Dick Tower but was unable to. He gave me a "Raymond" number to give to Dick Tower and asked me to have Dick call him at 5:45 p.m. through that number if he couldn't get the tower via the usual Highlands number. I said I would do this. I asked him how the weather was out there since it was raining, sleeting, snowing, and blowing inshore. He said that it was the same way out there. I asked him how the tower was acting. He said that it had been stormy since Saturday night with northeast winds of about 60 knots and seas from the northeast now about 25 to 30 feet high. He said that the tower had been very steady up until 10:30 a.m. approximately when there was a loud noise. He said that apparently something gave down below. I asked him what he thought it was and Henry said that he didn't really know and they couldn't go down to find out at this time. He said that since 10:30 a.m., the tower had begun to move and oscillate and seemed to have a rotary motion. I asked him how much he thought it was moving. He said about 50 percent of what it had around the middle of December 1960 and before the clamp at —75 had been installed. He said that the clamp was 100 percent complete including the additional reinforcing cover plate and all pin plate bolts double nutted. Henry also stated that they had completed welding and reinforcing of all cracks in the X-bracing above water including installing the vertical shear plates at the vertex on Saturday (January 14). He said that up until a little while ago they had not been able to get on deck or the maintenance scaffold due to winds up to 60 knots. A while ago he and Captain Phelan had gotten down on the maintenance scaffold as the wind let up a bit and had found a 20-inch vertical crack at the intersection where the interior vertical ⅝-inch thick gusset plates met at A leg, from the AB and AC sides. I asked if there was anything else they had observed and he said no, because they couldn't move the maintenance scaffold due to the wind. I asked him what the weather reports indicated. He said that they were trying to get all reports available. They expected a lull in the morning at which time they would try to get off by "choppers," which had been alerted. What they were concerned about was a report that two lows were expected to combine off of Cape Hatteras and move up the next day. He said that the AKL–17 had been taking quite a beating trying to stay close to the tower in the heavy seas. I said that I'd call Dick Tower right away and give him the message and telephone number. Henry did not sound overly concerned at this time.

4:54 p.m.: Called Dick Tower and gave him the message and number to call for Henry.

5:30 p.m. (approximately): Received telephone call from Mr. DiCocco in Syracuse. He had just gotten in from a ride with his wife in nice weather up there. I pointed out that it was miserable in New York. He wanted to know what I knew about conditions on the tower. I filled him in on my conversation with Henry.

Statement of Work, Repair Hurricane Damage—Texas Tower No. 4, Dated September 21, 1960

Item 1.—The contractor shall replace the revolving maintenance platform (referred to hereinafter as the "flying bridge") at Texas tower No. 4 to match the one which existed prior to September 12, 1960, in all respects except for the folding foot ladder which was attached to the bottom portion of the flying bridge. The contractor shall fabricate a new flying bridge which matches the old flying bridge in all physical respects (except for the foot ladder). The contractor shall transport the flying bridge to the off shore location known as New York Shoals and shall erect the flying bridge on the underside of the platform of Texas tower No. 4. The completed installation will be such that the operation and performance of the new flying bridge will equal or better operation and performance of the old flying bridge prior to its destruction on September 12, 1960. The new flying bridge will be complete in every respect including painting. Any parts and/or accessories (such as pinion gears, motor drive

mechanisms, etc.) which are salvageable from the old flying bridge may be reused on the new installation if approved by the using agency and if a financial credit can be mutually agreed upon between the Air Force and the contractor.

The contractor shall dismantle the old flying bridge, transport same to the mainland and dispose of same as the contractor sees fit.

Item 2.—As soon as practicable, either before, during or immediately after the installation of the new flying bridge, the contractor shall inspect all the welded brace-to-caisson joint connections above the water line for structural integrity utilizing magnaflux testing methods and procedures. Within the limits of feasibility all visible and/or accessible welded joint regions will be tested including the delta truss connections, and the 10-inch pipe strut connections as well as the vertical "finger" plate connections.

Item 3.—As soon as practicable, either before, during, or immediately after the installation of the new flying bridge, the contractor shall perform an underwater diving inspection of all joints beginning at the —23-foot level to the ocean bottom at −185 feet.

Item 4.—The contractor shall furnish a narrative report to the Air Force in 10 copies covering the inspection findings for items 2 and 3 above. The report shall be as comprehensive as possible and shall describe as completely as possible the existing structural defects discovered from the level of the ocean bottom to the level of the caisson-to-platform connections. The report shall include any and all documentation which will be of assistance to the Air Force in visualizing and understanding the location, nature, and extent of the structural damages. This documentation shall consist of photographs (including underwater photographs) and as-built drawings or sketch plates which would be meaningful and useful in supporting the narrative portion of the report. Photographs, in particular, will be left in large part to the discretion of the contractor. The position and direction of all cracks in the above-water joint connections will be accurately indicated on as-built drawings or sketch plates and shall be photographed as well, if said cracks are large enough to be captured on film properly. Underwater photography will be held to a minimum and photographs will be taken only of those pin-connected joints which, in the opinion of the contractor, will require repair or pin replacement. The report will include the contractor's appraisal of the structure as a whole along with specific recommendations as to the nature and extent of the repair work which the Air Force should accomplish, if any, to correct the damages which are detected under items 2 and 3 above. (Finally, the report will include if possible, a statement concerning the tower's present structural capacity or incapacity to withstand future storm conditions within the limits set by the original design criteria of winds up to 125 knots in combination with breaking-wave action having a crest height of 35 feet as measured above mean sea level. This statement of the present structural stability and storm-worthiness will be of key importance to the Air Force in determining the limits of safety for establishing storm warning personnel evacuation procedures for Texas tower No. 4 to prevent the loss of life in future.)

MORAN, PROCTOR, MUESER & RUTLEDGE,
New York, N.Y., January 4, 1961.

Re: engineering work, Texas tower No. 4.

J. RICH STEERS,
New York, N.Y.

GENTLEMEN: In connection with your field examination of Texas tower No. 4 in October and November 1960 following Hurricane Donna, we wish to confirm our conversations regarding our participation in this work. We understand that the Air Force concurs in our activity in this matter.

We agree to examine the results of your findings of damage both above and below water on Texas tower No. 4, to evaluate any structural deficiencies which may be found, and make recommendations as to repairs or modifications to be made to the tower as a result of your findings. We agree to do this work for the sum of $2,500 which would not include the design of, or the preparation of specifications for, any new work which might be required as a result of your examination of the tower and our recommendations.

Very truly yours,

WILLIAM H. MUESER.

Senator STENNIS. Certainly many questions arise from the fact that the several efforts over the long period of time failed to effect the repairs or restore the tower to its intended strength.

So far as your construction itself is concerned, however, it seems to have been sound. The inability to make the repair underwater effectively doesn't reflect on your company as I see it. Of course, I am a novice in that field.

I want to ask you whether the radar instruments on the tower continued to function in spite of all the motion and movement and obvious danger involved prior to January 1961?

Mr. RAU. I can't answer that question, Mr. Chairman, because I am not qualified to.

Senator STENNIS. Well, did you hear it discussed at the January 1961 conference?

Mr. RAU. I didn't think they had a complement large enough aboard the Texas tower No. 4, from sometime in November on, that could operate this radar equipment.

Senator STENNIS. Did you hear it discussed before they reduced the number of personnel?

Mr. RAU. I am sorry, Mr. Chairman.

Senator STENNIS. I asked whether you heard discussion by the Air Force or anyone in authority that this motion was so great that the radar wouldn't function?

Mr. RAU. No, sir; I did not.

REDUCTION IN NUMBER OF AIR FORCE PERSONNEL

Senator STENNIS. Even after Hurricane Donna, so far as you know, the radar continued to function until the time the crew was cut down in number?

Mr. RAU. I was not told about that.

Senator STENNIS. You don't know anything to the contrary?

Mr. RAU. No, sir.

Senator STENNIS. Well, do you know why the crew was reduced? What was your understanding of why the Air Force reduced the crew?

Mr. RAU. Excuse me, sir.

Senator STENNIS. Yes.

Mr. RAU. We were—we knew nothing about the reducing or the decision to reduce the number of men aboard the tower until actually after it happened, and I don't know who made the decision or what decision was made.

Senator STENNIS. I am told that the crew was reduced in number by the Air Force on November 16, 1960.

Mr. RAU. That is, as I recall, about the date, sir.

Senator STENNIS. I wanted to know whether the crew was reduced because the radar would not function or because it was considered dangerous for them to be out there? Can you shed any light on that question?

Mr. RAU. I cannot answer that, Mr. Chairman, because I do not know the reason.

Senator STENNIS. Well, that is why I asked you previously about whether there was any discussion of danger in January.

It seems that we haven't heard anything about whether the radar was functioning, but it does appear that 2 months before the tower collapsed, the crew had been greatly reduced. Certainly an almost conclusive inference arises from all the proof that this was done because of the dangerous condition of the tower.

Mr. RAU. That may be assumed, Mr. Chairman.

Senator STENNIS. I don't think we can assume things, Mr. Rau; we must have facts. I wanted to know whether you can shed any light on that directly.

For the information of those who may be interested, I think that this concludes almost all of the hearings on this matter. There is an additional witness that we will hear next Wednesday, and when we do take a recess it will be until 10 o'clock next Wednesday morning.

In the meantime, if either the Air Force or the Navy wish to present further testimony concerning this matter, they will be given an opportunity to do so and may make arrangements by contacting the Staff Director, or Mr. Kendall, or Mr. French.

Is there any other point you wish to cover?

Mr. RAU. No, sir; I do not, Mr. Chairman.

Senator STENNIS. All right.

With special thanks, Mr. Rau, to you and your associates, the committee will now take a recess until 10 o'clock next Wednesday morning.

(Whereupon, at 12:35 p.m., the subcommittee was recessed, to reconvene at 10 a.m., on Wednesday, May 17, 1961.)

INQUIRY INTO THE COLLAPSE OF TEXAS TOWER NO. 4

WEDNESDAY, MAY 17, 1961

U.S. SENATE,
PREPAREDNESS INVESTIGATING SUBCOMMITTEE
OF THE COMMITTEE ON ARMED SERVICES,
Washington, D.C.

The subcommittee (composed of Senators Stennis (chairman), Symington, Bartlett, Jackson, Bridges, Saltonstall, and Smith) met, pursuant to recess, at 10:05 a.m., in room 235, Old Senate Office Building, Senator John Stennis, presiding.

Present: Senators Stennis, Saltonstall, and Smith.

Also present: Staff members, Preparedness Investigating Subcommittee: James T. Kendall, chief counsel; Stuart P. French, professional staff member.

Senator STENNIS. All right, the subcommittee will come to order, please.

Members of the subcommittee, the Chair has a short opening statement.

The subcommittee today continues its inquiry into the facts surrounding the collapse into the Atlantic Ocean of Texas tower No. 4 on January 15 of this year, taking the lives of 28 persons.

During previous sessions, the subcommittee has heard from representatives of the Air Force; from the firm which actually constructed the tower; representatives of the Navy who were in overall charge of design and construction of the tower; engineers and divers who made actual studies and underwater inspections of the tower after it was constructed, and from officials of a pioneer firm in the field of erecting such structures.

From their testimony we believe now we almost have a complete story surrounding the short-lived and tragic history of Texas tower No. 4.

However, the picture cannot be complete without hearing from officials of the firm of Moran, Proctor, Mueser & Rutledge which was responsible for the design of the tower.

We are privileged this morning to have two members of that firm here today: Dr. Philip Rutledge and Mr. Theodore Kuss. We understand that the firm used a patented process developed by Mr. Kuss to up-end and erect the tower on site.

Inferences which might be drawn from previous testimony here might raise some questions as to the design, method of construction, and stability of the tower after it was erected.

For the record, and for the benefit of those gentlemen who are here today to testify and their firm, we would like to make it clear that we recognize clearly the problems that are necessarily involved.

It may very well be that the witnesses and their firm may have claims asserted against them for civil liability as a result of the collapse of the tower.

I emphasize that there may be such a situation. I do not state that such claims exist; I do not know.

Recognizing their rights as citizens and private individuals, the subcommittee is reluctant to take any action which might conceivably jeopardize or infringe upon their defense to any claims which may be asserted.

We feel the testimony of these gentlemen will benefit both the subcommittee and the firm they represent. We also feel it is possible that an unfavorable inference might be drawn from their failure or refusal to testify.

However, gentlemen, if you now request that you be relieved from testifying upon the ground that it may jeopardize your defense of such claims, we will reluctantly excuse you.

Mr. RUTLEDGE. Sir, we will be happy to answer any questions.

Senator STENNIS. Thank you. That is a very fine spirit, and we appreciate it very much.

Gentlemen, as I have already said to you in our little talk a while ago, it is the unbroken custom of this subcommittee that all witnesses be sworn.

Will you please stand and be sworn?

Do you and each of you solemnly swear that your testimony in these hearings will be the truth, the whole truth, and nothing but the truth, so help you God?

Mr. RUTLEDGE. I do.

Mr. KUSS. I do.

Senator STENNIS. All right.

Now, the Chair feels, members of the subcommittee and you gentlemen who are going to testify, that this matter can be taken up as well and perhaps more thoroughly by questioning these two gentlemen at the same time. We can proceed more quickly in that manner.

So if there is nothing from any member of the subcommittee, I am going to ask Mr. Kendall, our chief counsel, to proceed with the questioning.

TESTIMONY OF PHILIP RUTLEDGE AND THEODORE KUSS, MORAN, PROCTOR, MUESER & RUTLEDGE, NEW YORK, N.Y., ACCOMPANIED BY FORBES D. SHAW, OF THE FIRM OF WHITMAN, RANSOM & COULSON, NEW YORK, N.Y.

Mr. SHAW. I would like to say that Mr. Rutledge would like to make a preliminary statement. There is no prepared statement, but I think it would be well at this time for him to make an opening statement.

Senator STENNIS. Thank you for that suggestion, and we shall be very glad to have a statement from either or both of you.

Mr. Shaw, the gentleman who has just spoken, is the attorney for these gentlemen, and we are very glad to have you, Mr. Shaw.

DESIGN ENGINEERS' REPORTS TO NAVY AND AIR FORCE

Mr. Rutledge. Mr. Chairman, we have no prepared statement. We have in lieu of a prepared statement submitted a series of reports to our clients, who initially were the Department of the Navy and later the Air Force. These reports are the Feasibility Report which was issued in 1954; the Design and Construction Report which was issued in 1959; a report on design of above-water braces, shown in red here on the model, to the Air Force in 1960; a report on the construction of the above-water braces to the Air Force and their effect, issued in August or September 1960; and a report on motion and stability, issued to the Department of the Navy.

I believe that these reports have been available to your staff, sir.

Senator Stennis. All right. Thank you very much.

Mr. Rutledge. Yes, sir. This most important one——

Mr. Kendall. Mr. Chairman, I believe we have copies of all of those except the last three.

Senator Stennis. All right. Those copies that you have available there you could leave for our files, and we shall return them after we are through. They are for the files, and not for the record at this point.

Mr. Rutledge. Yes, sir.

Senator Stennis. You may proceed, sir, if you have any further opening statement.

Mr. Rutledge. I think that completes our statement, sir.

Mr. Kendall. I believe your presence here this morning is as a result of subpenas issued by the subcommittee?

Mr. Rutledge. Yes, sir.

Mr. Kuss. Yes, sir.

Mr. Kendall. Both of you are with the firm of Moran, Proctor, Mueser & Rutledge?

Mr. Kuss. That is correct.

Mr. Rutledge. That is correct.

Mr. Kendall. Will each of you apprise the committee of your engineering background and qualifications?

Mr. Rutledge. I graduated from Harvard College in 1927, received a master of science degree from MIT in 1933, received a doctor of science degree from Harvard University in 1939.

In the interim, I worked as a construction engineer, as a structural designer for Stone & Webster Engineering Corp.; as an instructor in the Harvard Engineering School; as a professor at Purdue University, as professor of civil engineering. I was professor of civil engineering and chairman of the department of Northwestern University Technological Institute, and in January 1952 joined the firm of Moran, Proctor, Mueser & Rutledge.

Mr. Kendall. Mr. Kuss, would you do the same, please?

Mr. Kuss. I am a graduate of MIT, 1925. I am also a graduate of the Bethlehem Steel training course for graduate engineers.

Since that time, I have worked for various contractors and consulting engineers on heavy construction.

I was chief engineer for the Pacific Bridge Co., San Francisco, for 7 years, engaged in building bridge foundations, drydocks, salvage of ships at Pearl Harbor, and building of floating drydocks. That is typical of my work.

Mr. KENDALL. How did the Moran, Proctor firm become involved in the Texas tower program?

PARTICIPATION OF MORAN, PROCTOR FIRM BROUGHT ABOUT BY INVITATION OF MR. ANDERSON

Mr. RUTLEDGE. Well, the latter part of March 1954 we received a telephone call from Mr. Anderson of the firm of Anderson & Nichols stating in very vague terms that he had a project. As I say, he described it in vague terms. He requested Mr. Proctor of our office to come to Boston so that he could describe the nature of the project, which he could not describe over the telephone.

Senator STENNIS. Just a minute.

Gentlemen, move those microphones over nearer to you, please.

Do you not have an extra one? Rig up another one there for their convenience, please.

You see, the press and those that are interested in this matter must have a chance to hear, gentlemen. We can hear you all right, but unless you use the microphone, the audience cannot.

If you will move it over a little closer to you and proceed, he will put in another one there as we progress.

Mr. KENDALL. Then I take it that originally you were invited to participate in the project by Mr. Anderson, and that you had not been contacted by a representative of the Navy prior to that time?

Mr. RUTLEDGE. To my knowledge, that is right.

Mr. KENDALL. And you subsequently agreed to go into a joint venture for this project; is that correct?

Mr. RUTLEDGE. After a number of conferences, we did.

Mr. KENDALL. Mr. Anderson, in testifying before the committee, stated that your firm was invited to join in this joint venture, and that your responsibility under his concept was for the footings only; that is, the part of the structure actually under the bottom of the sea. Is that in accord with your understanding?

Mr. RUTLEDGE. No, sir.

Mr. KENDALL. What is your understanding?

Mr. RUTLEDGE. Through a series of conferences from the end of March 1954 to the end of May 1954, the nature of the project was developed. The two firms reached agreement on the parts of the work each firm would do. We submitted a series, we prepared a series of letters to the 1st Naval District, proposals for the work. The letter on which the contract was based was submitted on June 1.

At the same time we made an agreement between the two firms on the breakdown of the work, which firm would do what work.

Mr. KENDALL. What was that agreement, sir?

Mr. RUTLEDGE. The agreement is a signed document listing the items of work, the firm that is to do each piece of work, and the proportion of the fee that is applicable to each piece of work.

Mr. KENDALL. You say that was a signed document?

Mr. RUTLEDGE. Yes, sir.

Mr. KENDALL. What was the date of the document, please, sir?

Mr. RUTLEDGE. The signatures are dated June 1, 1954.

Mr. KENDALL. Would you make a copy of that available for the record, please, sir?

Mr. RUTLEDGE. We would be glad to.

(The document referred to is as follows:)

Texas towers—Fee breakdown

	Item	Amount
A–N	1. General administration	$1,500
A–N	2. Project management and engineering direction	6,000
A–N	3. Collection of data, liaison with Navy, Air Force, consultants, etc	10,500
M.P.M. & R	4. Preliminary studies for foundations, design waves, wave forces, analysis for basic structures and forces, location of structures for wave and foundation conditions.	16,000
M.P.M. & R	5. Preliminary design of foundation structures, review of proposed schemes and construction methods.	26,000
A–N	6. Functional design of superstructure, living space, equipment, power, storage, and supply.	9,250
A–N	7. Preliminary design of superstructures and mechanical equipment	14,500
M.P.M. & R	8. Cost estimates and outline specifications for foundation types and proposed schemes.	14,000
A–N	9. Cost estimates and outline specifications for superstructures, equipment, etc.	9,250
M.P.M. & R	10. Summarization of studies and theories for design criteria for foundations.	5,000
Both	11. Preparation of report	8,000
Both	12. Contingencies	10,000
	Total	130,000
M.P.M. & R		70,000
A–N & Co		60,000

Mr. KENDALL. Was this before or after the meeting with Captain Albers when he, himself, specified and dictated what the respective responsibilities of the firms would be?

Mr. RUTLEDGE. My understanding is that, from reading the testimony, that the meeting in question was on July 22, 1954.

Mr. KENDALL. This was prior to that time?

Mr. RUTLEDGE. This was June 1, 1954.

Mr. KENDALL. Prior to reaching that agreement, had you or anyone in your firm had any discussions with either Captain Albers or Captain Wesanen concerning division of the responsibilities?

Mr. RUTLEDGE. We had—to my knowledge, we had had no discussions on division of responsibility. We had many discussions with then Commander Albers and the engineers of the 1st Naval District regarding the scope of the work, the problems involved in the work. But we did not discuss with them the division of the work between the two firms.

DIVISION OF WORK BETWEEN ARCHITECT-ENGINEERING FIRMS

Mr. KENDALL. Well, can you tell us briefly what was the division of work, as indicated by this signed agreement that you have referred to?

Mr. RUTLEDGE. It consists of 12 items.

The first item, 1, general administration; Anderson & Nichols, $1,500;

Item 2, project management and engineering director; Anderson & Nichols, $6,000;

Item 3, collection of data, liaison with Navy, Air Force, consultants, etc.; Anderson & Nichols, $10,500;

Item 4, preliminary studies for foundations, design waves, wave forces, analyses for basic structures and forces, location of structures for wave and foundation conditions; Moran, Proctor, Mueser & Rutledge, $16,000.

Item 5, preliminary design of foundation structures, review of proposed schemes and construction methods; Moran, Proctor, Mueser & Rutledge, $26,000;

Item 6, functional design of superstructure, living space, equipment, power, storage supply; Anderson & Nichols, $9,250;

Item 7, preliminary design of superstructures and mechanical equipment; Anderson & Nichols, $14,500;

Item 8, cost estimates and outline specifications for foundation types and proposed schemes; Moran, Proctor, Mueser & Rutledge, $14,000;

Item 9, cost estimates and outline specifications for superstructures, equipment, et cetera; Anderson & Nichols, $9,250;

Item 10, summarization of studies and theories for design criteria for foundations; Moran, Proctor, Mueser & Rutledge, $5,000;

Item 11, preparation of report; both firms, $8,000;

Item 12, contingencies; both firms, $10,000.

Mr. Kendall. Did that division of responsibility remain throughout the completion of the project, or was any change made subsequently?

Mr. Rutledge. This continued throughout the feasibility report. At the completion of the feasibility report, the amount of work involved in design was different than in the feasibility report, because we were to design five structures which were quite different structures, but the superstructure, the architectural, electrical, mechanical, was close to being the same in each of the five.

Mr. Kendall. Dr. Rutledge, a subpena was served on you, in effect requesting that you produce all vouchers or memoranda showing expenditures of money for the entertainment or social activities of Captain Wesanen during this time. Did you do that, sir?

Mr. Shaw. If I might interrupt, Counsel?

Mr. Kendall. Yes, sir.

Mr. Shaw. There was a specific time period specified in the subpena, as I recall.

Mr. Kendall. I think that is correct, sir.

Mr. Rutledge. Sir, we searched our files for the time period specified, which was—I don't have it in front of me.

Mr. Kendall. June 1, 1956, through January 1, 1958.

Mr. Rutledge. We found nothing for the specified periods, sir. We searched our files from the beginning of the Texas tower investigation to the present day. We find one expense slip in the amount of $52.55.

Mr. Kendall. That was for Captain Wesanen?

Mr. Rutledge. Yes, sir.

Mr. Kendall. For what purpose?

Mr. Rutledge. This was July 22, 1954, railroad and taxi to Bronxville, car mileage to Blind Brook Country Club, tolls, charges, Blind Brook Country Club, dinner.

Mr. Kendall. Dr. Rutledge, in the design of this tower, I believe it was contemplated originally that the resistance to the passage of wind should be kept at a minimum; is that correct? Wind and waves, that is?

Mr. Rudledge. Yes, sir; that is correct.

Mr. Kendall. Now, is it not true that tower No. 4 would be subjected, both to aerodynamic and hydrodynamic forces?

Mr. RUTLEDGE. Yes, sir; all of the towers were so subjected.

Mr. KENDALL. Why was only a static force analysis made in designing the towers?

STATIC FORCE ANALYSIS COMPARED TO DYNAMIC FORCE ANALYSIS IN DESIGN

Mr. RUTLEDGE. Sir, the analysis was based on dynamic loading. The forces acting on the tower were computed from dynamic forces of waves and wind exerted on the tower, using the maximum combination of forces produced by the design wind and wave, which was the design wave hitting two of the legs with maximum force, and with a portion of that wave or another wave acting on the third leg with a force corresponding to the position of the wave.

These forces, which are dynamic forces, were translated into stresses in the structure on the basis of static analysis for an instantaneous condition of the dynamic force.

Mr. KENDALL. Are you saying now that you made a dynamic force analysis, as well as a static force analysis?

Mr. RUTLEDGE. The term "dynamic force analysis," I believe, is somewhat misleading. We computed the spring constants and the natural frequencies of these towers to compare them with the frequency of application of wave forces. But I am not sure of what you mean by a dynamic force analysis.

Mr. KENDALL. Well, state for the record what the difference is between a dynamic force analysis and a static force analysis, basically.

Mr. RUTLEDGE. I still am not clear. We use dynamics to get the loads, the forces acting on the structure. From there on one has to compute the stresses on the basis of a static analysis. The dynamics is to compute the natural frequency of the structure.

Mr. KENDALL. I believe, Mr. Brewer, in testifying before the committee, if I understood him correctly, testified that waves of 10 to 12 feet in height caused a greater stress than waves of 30 feet in height. I believe he so stated in his report.

Isn't that an example of why dynamic forces should have been calculated?

Mr. RUTLEDGE. The condition that Mr. Brewer was describing in his report was for small waves that create very small stresses, where the wave length is equal to the distance from one pair of legs to the third leg, so that the crest of the wave hits—the crest of two waves hit all three legs at the same time.

This condition creates stresses which are far below the stresses that are used for the actual design analyses, because the waves are smaller.

He is comparing this condition of 10- to 12-foot waves with 28-foot waves, or 30-foot waves. But our design analyses were for 60-foot waves of this type, or for 35-foot breaking waves.

Senator SALTONSTALL. What was that last statement again, please?

Mr. RUTLEDGE. His comparison is for 10- to 12-foot waves versus 28- to 30-foot waves, from his measurement. His stresses, then, are in the order of 2,000 to 2,500 pounds per square inch. Our design analyses are based on 60-foot greenwater waves, or 35-foot breaking waves, which create stresses in the order of 20,000 pounds per square

inch. So the magnitude of the stresses is approximately one-tenth of those of the design stresses.

Senator SALTONSTALL. Mr. Chairman?

Senator STENNIS. Senator Saltonstall?

Senator SALTONSTALL. I would like to ask our Counsel, if we have had any testimony of anything greater than a 35-foot wave? I had not heard of any that I can remember.

Mr. KENDALL. I think the testimony shows that during Hurricane Donna, there were waves of at least 50 feet in height.

Senator SALTONSTALL. Fifty feet.

Mr. KENDALL. But Mr. Brewer's testimony and his report did show that you had a greater platform movement with 10- to 12-foot waves than with a 30-foot wave?

Mr. RUTLEDGE. I believe this is correct. The movements were still relatively small movements.

I might also point out that Mr. Brewer's measurements were made at a time when we had discovered that the collars on the—at least one of the replacement braces were loose, so that the braces were not acting effectively.

Mr. KENDALL. Mr. Rutledge, when was Mr. Kuss employed by the Moran, Proctor firm?

Mr. RUTLEDGE. This was about January or February 1955.

Mr. KENDALL. Did Captain Albers have or play any part by suggestion, recommendation, introduction, or otherwise, in putting Mr. Kuss in touch with your firm?

Mr. RUTLEDGE. No, sir. We had known Mr. Kuss for many years. Mr. Kuss was chief engineer of the Pacific Bridge Co. on the Golden Gate Bridge when we were working on the caissons for that bridge.

Mr. KENDALL. Had Mr. Kuss' patented tip-up method ever been considered at all in the design of tower No. 4 prior to his employment by Moran, Proctor?

Mr. RUTLEDGE. It was considered; yes, sir.

KUSS ERECTION METHOD USED FOR FIRST TIME

Mr. KENDALL. Had the Kuss method ever before been used in the erection of an offshore structure such as this?

Mr. RUTLEDGE. Not before 1955; no, sir.

Mr. KENDALL. Has it been used since that time?

Mr. RUTLEDGE. According to magazine advertisements, it has; yes, sir.

Mr. KENDALL. Mr. Kuss has it patented. He would know whether or not it has been used.

Mr. KUSS. Yes, sir; the method has been used. It was used last year on a tower that Standard Oil put up in the Pacific.

Mr. KENDALL. In what depth of water, Mr. Kuss?

Mr. KUSS. 100 feet.

Mr. KENDALL. Was the fact that Mr. Kuss was the holder of this patent a consideration which led to his employment by your firm, Mr. Rutledge?

Mr. RUTLEDGE. No, sir.

Mr. KENDALL. Now, prior to the opening of the bids for towers No. 1, No. 3, and No. 4, on November 1, 1955, did any member or employee

or representative of the Moran, Proctor firm have any conversation or discussion or other communication with any representative of the DeLong Corp. concerning the design and method of construction of Texas tower No. 4?

Mr. Rutledge. We may have been asked questions about the design drawings and specifications. Several contractors asked us questions about these.

Mr. Kendall. Well, I make specific reference to Mr. Suderow. Did any member of your firm or any employee of your firm have any conversation or discussion with him about this design?

Mr. Rutledge. It is very possible. Mr. Suderow was chief engineer of the DeLong Corp. They were in a joint venture that built Texas tower No. 2. It's very possible that they asked questions about the design and specifications for these three towers.

Mr. Kendall. Is it true that DeLong or his representative expressed considerable doubt and made considerable objection to the use of pin connections and this Kuss tipover method?

Mr. Rutledge. It was not expressed to us, sir, to my knowledge.

Mr. Kendall. Then I take it it is your testimony that there was no agreement, understanding, or recognition, either express or implied, with DeLong and any member of your firm, that if he were the low bidder on tower No. 4, he would be permitted to use a substitute or alternate method of construction?

Mr. Rutledge. We had no authority to make such an agreement, and we did not make any agreement.

Mr. Kendall. We have here, and it has been introduced in the record, Mr. Rutledge, a drawing dated October 17, 1955, which Colonel DeLong has identified as his proposed method of constructing and erecting tower No. 4. Are you familiar with that drawing?

Mr. Rutledge. No, sir.

Mr. Kendall. Will you look at it, please, sir?

Mr. Rutledge. Yes, sir.

To my recollection, I saw this drawing at a meeting in the Bureau of Yards and Docks, in Capt. Garner Clark's office.

Mr. Kendall. Captain who's office?

Mr. Rutledge. Garner Clark.

Mr. Kendall. What was his position?

Mr. Rutledge. He was Assistant Chief of the Bureau of Yards and Docks for construction.

Mr. Kendall. Located where?

Mr. Rutledge. In Washington, D.C., sir.

Mr. Kendall. And you saw it in Washington?

Mr. Rutledge. That is my recollection; yes, sir.

Mr. Kendall. Was that before or after the opening of bids?

Mr. Rutledge. The date of the memorandum concerning this, that the meeting was on October 20, 1955.

Mr. Kendall. That drawing does show an alternate or substitute method of constructing and erecting tower No. 4, does it not?

ALTERNATE METHOD OF CONSTRUCTION

Mr. Rutledge. It shows a method that is somewhat similar to one of the methods we studied, which is described in our Design and Construction Report.

Mr. KENDALL. But it is different from the tipover method that was actually designed?

Mr. RUTLEDGE. It's different in the way the connection is made between the foundation structure and the platform.

Mr. KENDALL. It is different in other particulars, too, is it not, Mr. Rutledge? There is no vertical tow to the site; there is no tipover.

Mr. RUTLEDGE. It shows a vertical tow with a 65-foot draft.

Mr. KENDALL. I meant there was no horizontal tow; excuse me, sir.

Mr. RUTLEDGE. Yes, it shows a vertical tow at a 65-foot draft.

That was one of our considerations. There is no harbor on the east coast, to our knowledge, that has a 65-foot draft out of a shipyard.

Mr. KENDALL. Why did you see this drawing on October 20?

Mr. RUTLEDGE. Sir, may I read my memorandum on this subject?

Mr. KENDALL. I hope it isn't too lengthy, Mr. Rutledge.

Mr. RUTLEDGE. This is one paragraph, sir.

Mr. KENDALL. Go ahead.

Mr. RUTLEDGE (reading):

Following this conference, Capt. Garner Clark asked Messrs. Kuss and Rutledge to come to his office with Commander Albers and Commander Aubey. Captain Clark was concerned about a visit from Colonel DeLong and George Ferris, in which they tried to persuade Captain Clark that they could produce an alternate or modified design for TT–4 in 10 days. Captain Clark has refused to give them a permission to submit a bid based on an alternate design. Both Mr. Kuss and the writer doubt that the various forms of alternate design as described at this meeting can be made feasible, and both are sure that an alternate design which gives any adequate consideration to the structural and construction problems cannot be produced in any time period in the order of magnitude of 10 or 20 days. After discussion of this situation, Captain Clark agreed that he was satisfied that he had done the right thing in rejecting the proposal of a bid based on any form of alternate design.

ALTERNATE METHOD DISAPPROVAL

Mr. KENDALL. So you disapproved this drawing and adhered to the Kuss method; is that right?

Mr. RUTLEDGE. According to this memorandum and the situation, Captain Clark had already disapproved it and he wanted confirmation of his disapproval.

Senator STENNIS. Who made that memorandum, Mr. Rutledge?

Mr. RUTLEDGE. I wrote the memorandum, sir. This is the last paragraph of a three-page memorandum. The first 2½ pages are concerned with the problem of design of fenders for the towers 1, 3, and 4.

Mr. KENDALL. Would you make a copy of that memorandum a part of the record, please, sir?

Mr. RUTLEDGE. We will be glad to.

(The document referred to is as follows:)

MEMORANDUM

To: Office.
From Philip C. Rutledge.
Re: Fenders for Texas towers structures.
Date: October 21, 1955.

A conference was held in the offices of the Bureau of Yards and Docks, Washington, D.C. on Thursday, October 20, 1955, to discuss the problem of fenders to protect the legs of Texas towers TT–1, TT–3 and TT–4. Attending this conference for the Bureau of Yards and Docks were Commander Albers, Commander Aubey, Mr. Gordon Edwards, Mr. Vannce Duncan, Mr. James Ayres and Mr. Ralph Stokes. For M.P.M. & R., Messrs. T. M. Kuss and P. C. Rutledge

attended. The discussions at this conference lasted from 10 a.m. to 4:30 p.m. with about 1 hour break for lunch. After very lengthy discussions of the abilities of the tower legs to survive an accidental impact of a barge or ship it was finally decided that fenders would be used on all three towers. We were instructed to proceed with final design drawings for the fenders of the towers on the basis of the following decisions:

(1) It was decided to use the chain-type fender for which we have prepared preliminary designs.

(2) It was decided that the design energy to be absorbed by the fender should be one-half of that previously used in our fender design studies. In other words, the design energy to be absorbed by the fender should be 25 percent of the total energy of a 500-ton barge or ship with an approach velocity of 10 knots.

(3) It was decided that each fender should be supported by 12 chains on the grounds that the chains can be used to provide protection for the legs above and below the depth covered by the actual fender structure and on the grounds that the chain is a small part of the cost and it seems probable that Commander Albers can obtain salvage anchor chain at nominal or no cost for this use.

(4) For the fender structure itself in the region of mean sea level it was decided to use a three ring type structure with the ring spaced 10 feet apart vertically and braced together as shown on our preliminary design drawing.

(5) It was decided that we should investigate the desirability of using horizontal rings of chain, cable, or pipe struts between the vertical chains at one or more levels above the fender structure. Our studies on the desirability of such horizontal supplementary rings are to be submitted to the Bureau of Yards and Docks.

It was agreed that these represent final decisions in regard to fenders and that we can proceed with the final design drawings for the fenders on this basis, subject only to the usual review by the Navy of our design drawings. We should receive a letter from the Navy giving us these as final instructions. If we do not receive such a letter within the next few days, we shall have to write a letter stating that this is our understanding of the results of the conference.

Following this conference Capt. Garner Clark asked Messrs. Kuss and Rutledge to come to his office with Commander Albers and Commander Aubey. Captain Clark was concerned about a visit from Colonel DeLong and George Ferris in which they tried to persuade Captain Clark that they could produce a modified or alternate design for TT–4 in 10 days. Captain Clark has refused to give them permission to submit a bid based on an alternate design. Both Mr. Kuss and the writer doubt that the various forms of the alternate design as described at this meeting can be made feasible and both are sure that an alternate design which gives any adequate consideration to the structural and construction problems cannot be produced in any time period in the order of magnitude of 10 to 20 days. After discussion of this situation, Captain Clark agreed that he was satisfied he had done the right thing in rejecting the proposal of a bid based on any form of alternate design.

PHILIP C. RUTLEDGE.

Mr. KENDALL. Mr. Rutledge, in view of the greater water depth at the site of tower No. 4 and the more extensive bracing system and related matters, why is it that the bid of J. Rich Steers and Morrison-Knudsen was in practically the same amount for tower No. 4 as for tower No. 3? Can you explain that, sir?

Mr. RUTLEDGE. I cannot answer that question, sir, because I did not make the bids.

Mr. KENDALL. Yes, sir.

But on the basis of the design, do you not think that it would be reasonable that TT–4 would be more expensive to construct than TT–3?

COST COMPARISON BETWEEN TEXAS TOWERS NOS. 3 AND 4

Mr. RUTLEDGE. Apparently the contractors did not think so, according to their bids.

Mr. KENDALL. What is your judgment as an engineer, sir?

Mr. RUTLEDGE. The types of structures are different. The erection of tower No. 3 required nine supplementary legs, which subsequently had to be removed. The design of tower No. 4 did not require these supplementary legs. I am not in a position to read the contractor's mind, but apparently he thought that the various differences between the two resulted in an equal, approximately equal, cost.

Mr. KENDALL. I believe I asked for your judgment, Mr. Rutledge. I am sure you made some cost estimates when you put the bids out.

Mr. RUTLEDGE. We did make cost estimates, and I do not have those in front of me. But as I recall, they were in the order of $500,000 more for tower No. 4 than tower No. 3.

Mr. KENDALL. Would you say that DeLong's bid for tower No. 4, which was approximately $1,300,000 more than he had bid for tower No. 3, was somewhat more realistic than the bids of J. Rich Steers and Morrison-Knudsen?

Mr. RUTLEDGE. I would not say that it is more realistic; no, sir. The contractors' bid is, in my opinion, as realistic as one can get. It is each contractor's opinion of how much it's going to cost him to do the work, and he expects to make a profit on it.

Senator STENNIS. In keeping with the pattern of proceeding here, if you will permit an interruption now, Mr. Rutledge and counsel, I shall ask if Senator Saltonstall has any questions.

Senator SALTONSTALL. Thank you, Mr. Chairman. If counsel has a few minutes more to complete his questioning, I will gladly wait. If he will take a long time, then, I would like to ask a few questions at this time.

Mr. KENDALL. I have a considerable amount more, Senator.

Senator SALTONSTALL. I thank the chairman very much.

Mr. Rutledge, there were just several questions I would like to ask you, as a layman.

Now, you stated that this structure was designed for 50- to 60-foot waves, and that the stress, as I understand it, from those waves is very much greater than the stress exerted by 10- to 12-foot waves. As I understand it, the third leg would be hit at the same time as the first two legs by waves of 10 to 12 feet.

Mr. RUTLEDGE. Yes, sir.

Senator SALTONSTALL. And therefore, there would be a greater stress on the tower from a bigger wave if they came together, somewhat like an undertow, and one wave would be contacting the other; is that correct?

Mr. RUTLEDGE. I don't believe, if I understand you correctly, sir, that that's correct. The small waves create quite small stresses. But it's quite possible for the crest of two small waves to hit the three legs simultaneously, so that we double the small stress and we get a measured stress of approximately, according to Mr. Brewer's measurements, in the order of 3,000 pounds per square inch.

LARGE WAVE RESULTS IN GREATER STRESS

On the other hand, when a 60-foot wave, one 60-foot wave, hits the structure, we get stresses in the order of 20,000 pounds per square inch, or seven times as much.

Senator SALTONSTALL. In other words, you would believe that one big wave would give a lot more stress than the small waves, as Mr. Brewer testified?

Mr. RUTLEDGE. I am sure of it, sir.

Senator SALTONSTALL. Now, one question where there seems to be some considerable disagreement, if I recall the testimony correctly:

Who designed the structure from the superstructure down? It was my understanding, and I stand subject to correction, that Mr. Anderson testified that ultimately they had nothing to do below the superstructure, and that your firm designed all the legs and the support of those legs including the subsurface foundation of those legs; is that correct?

Mr. RUTLEDGE. That's correct, sir.

From the very beginning of this project, that was the situation.

Senator SALTONSTALL. Referring to that model for a moment, from the white part of the tower down, your firm had all the responsibility for design?

Mr. RUTLEDGE. We also designed everything below the white part and the main structure members around the white part.

Senator SALTONSTALL. I see. So that the Anderson firm designed the electronics and the arrangements of the bunks and the facilities above the platform?

Mr. RUTLEDGE. The structure contained a great deal of electrical, mechanical equipment, large diesel generators, a great deal of wiring to supply power to the radars. They had a large amount of electrical mechanical work to do, and also they did all of the location of partitions and this kind of thing inside the tower.

Senator SALTONSTALL. Am I correct in understanding that there was no previous construction of a tower at such depth of water, that you know of?

SIXTY FEET MAXIMUM DEPTH OF ALL PREVIOUS TOWERS

Mr. RUTLEDGE. That's correct, sir. When we made our studies in 1954, the maximum depth we could find was 60 feet that anyone had ever built a structure, and these were all in the Gulf of Mexico, where conditions are much less severe than in the North Atlantic.

Senator SALTONSTALL. And this was in 185 feet of water?

Mr. RUTLEDGE. This is 185 feet of water; yes, sir.

Senator SALTONSTALL. Did you have anything to do with supervising the actual construction after you created the design?

Mr. RUTLEDGE. Our responsibility was restricted to two items. We were required to advise the officer in charge of construction at his request. We were also required to have an engineer on the tower while borings were made at the exact location to certify that the ocean bottom materials were satisfactory for support of the tower.

Senator SALTONSTALL. So that after you completed the design of the legs, bracings and footings, you had no responsibility in supervising construction?

Mr. RUTLEDGE. Except for these two items.

Senator SALTONSTALL. Except for those two items, which were to determine that the borings were satisfactory below the sand, and what was the other one?

Mr. RUTLEDGE. To advise the officer in charge of construction, at his request.

Senator SATONSTALL. Did he make any such request?

Mr. RUTLEDGE. Yes, sir, a number of times we were called into consultation on the particular items.

Senator SALTONSTALL. And you have records of the advice that you gave him at that time?

Mr. RUTLEDGE. I am reasonably sure that we have records of all such meetings.

Senator SALTONSTALL. Well, now, did you at any time, when you gave such advice, inform the contractor or the Navy that you were proceeding in an unsafe way?

Mr. RUTLEDGE. No, sir. We would not advise the contracting officer that anything he wished to do was unsafe.

Senator SALTONSTALL. No, I mean did you find that he was doing anything unsafe?

Mr. RUTLEDGE. No, sir.

Senator SATONSTALL. So that you believed that your design was carried out and that the tower, as you designed it, was constructed properly?

Mr. RUTLEDGE. Well, there was the instance of loss of two of the folded-down braces, which was an accident, but certainly was not improper construction, and there was the replacement of these braces and certain difficulties in the installation of the replacements.

But beyond that, I would say yes, with these exceptions, the construction was as designed.

Senator SALTONSTALL. Now, did you approve of the method by which the template was moved to the location?

Mr. RUTLEDGE. Our approvals were restricted to items that were covered in the design and specifications. The actual procedure for towing the structure was part of the contractor's construction methods, which we did not approve in any form.

Senator SALTONSTALL. Well, when you made the design, did you contemplate that it had to be moved by sea from Portland to the location?

Mr. RUTLEDGE. Yes, sir, the design and specifications include the erection of the foundation structure, the part below the white top, in a horizontal position. They include the upending and placing in position by the Kuss patent and the design and specifications take full responsibility for the upending and placement, the actual rotating of the structure.

Senator SALTONSTALL. You approved of that?

Mr. RUTLEDGE. Yes, sir; that is part of the design and specifications.

Senator SALTONSTALL. Now, let me ask you this question:

Did you have any responsibility for, or take any part in, designing the supports that are marked in red on this model, after it was shown that there were difficulties?

Mr. RUTLEDGE. Yes, sir. We designed those red above-water bracings under a contract with the Air Force.

Senator SALTONSTALL. Did you believe that that increased the stress on the legs as a whole, when you put those red supports above water?

INCREASE IN STRENGTH THROUGH "X"-BRACING REPAIR OUTWEIGHED INCREASE IN STRESS THEY WOULD IMPOSE

Mr. RUTLEDGE. It increased the stress, the forces acting on the structure, but it increased the strength of the structure by an even greater amount than it increased the forces.

Senator SALTONSTALL. Well, then, you used the figures—I want to recall them correctly—a 60-foot wave would give how much stress?

Mr. RUTLEDGE. Approximately 20,000 pounds.

Senator SALTONSTALL. 20,000 pounds per square inch?

Mr. RUTLEDGE. Yes, sir.

Senator SALTONSTALL. How much did it increase the stress per square inch by putting in these supports above water?

Mr. RUTLEDGE. I believe Mr. Kuss has figures on this, sir.

Is that right?

Mr. KUSS. Yes.

Senator SALTONSTALL. Mr. Chairman, do you want him to answer?

Senator STENNIS. Yes, they are both witnesses.

Mr. KUSS. The installation of those red braces added about 51 tons of horizontal load on the tower as a whole.

Senator SALTONSTALL. I cannot hear you, Mr. Kuss.

Mr. KUSS. The addition of the red braces added 51 tons to the horizontal load on the tower from the wave action. Now, the basic loads that this 51 tons were added to were for wind, 418 tons; for wave, 401 tons. So that——

Senator SALTONSTALL. Well, now, 401 tons; how many pounds per square inch?

Mr. KUSS. I'll get to that later.

Senator SALTONSTALL. Excuse me.

Mr. KUSS. This is the load on the tower. I'm not talking about the stresses in the legs.

So this 51 tons additional added about 6 percent to the total horizontal force. Now, in turn, what that did to strengthen the tower is this:

It decreased the bending in the legs to 36 percent of the maximum design bending, original design bending. It decreased the stress in the critical strut—that is, the first horizontal below the red—do you follow me?

Senator SALTONSTALL. It decreased the stress there?

Mr. KUSS. It decreased that stress there to 65 percent of what it was before.

In other words, I am trying to point out that this bracing did far more to strengthen the tower than is brought in by the additional wave force. Of course, we knew all this when we put the braces on.

In addition, of course, it stiffened the tower, but those are engineering facts.

Senator SALTONSTALL. Well, now, did the cable bracing down below the water have any effect pro or con?

Mr. KUSS. Those cables were not in, sir. Those cables were not in.

Senator STENNIS. The cable bracing was not ever actually put in. It was planned, but the tower collapsed before that was carried out.

Senator SALTONSTALL. Go ahead.

Mr. RUTLEDGE. I would like to make it clear that the reason for this, and I believe Mr. Kuss' figures are based on this, is that the A–B side replacement braces—between minus 25 feet and minus 75 feet—these were believed to be somewhat ineffective, which made this upper bracing, we felt, necessary.

Senator SALTONSTALL. So that you believed that the upper bracing that was put in would be satisfactory to keep the tower safe?

Mr. RUTLEDGE. On the basis that the two replacement braces were not doing their job.

Senator SALTONSTALL. Let me ask you this question:

You mentioned Captain Clark of the Bureau of Yards and Docks. He refused to allow a bid on the DeLong design. Is that a correct understanding of your testimony?

Mr. RUTLEDGE. He stated that he refused to allow any alternate to the plans and specifications.

Senator SALTONSTALL. So that Captain Clark of the Bureau of Yards and Docks, who is the superior officer, as I understand it, of Commander Albers and Captain Wesanen, accepted your design as the design that he believed, as a representative of the Navy, was the proper design for this tower, No. 4?

Mr. RUTLEDGE. Yes, sir.

Senator SALTONSTALL. And there were no other designs considered, so far as you know, except yours?

OPEN BIDDING ON DESIGN

Mr. RUTLEDGE. Sir, this design was put out for open bidding. There were two bids eventually submitted by two joint ventures. To my knowledge, there was no irregularity or alternate in any bid submitted.

Senator SALTONSTALL. Then, after you completed your design, which encompassed everything below the upper platform, your only responsibility in connection with this tower came when the Navy officer in charge would ask you for your advice aside from your responsibility to determine that the soil conditions in the ocean floor were proper?

Mr. RUTLEDGE. Yes, sir. That's spelled out in our contract.

Senator SALTONSTALL. Now, how far down below the surface did those legs go? Fifteen feet, was it?

Mr. RUTLEDGE. They were to go 20 feet, as redesigned with caissons. That was relaxed to 18 feet because, when the structure was actually in place, the water depth was 185 feet, rather than the 180 feet that was supposed to be at the location where placement——

Senator SALTONSTALL. These legs were put down 18 feet below the level of the sand?

Mr. RUTLEDGE. Yes, sir.

Senator SALTONSTALL. And that, in your opinion, was satisfactory to hold this tower up?

Mr. RUTLEDGE. It was more than satisfactory; yes, sir.

Senator SALTONSTALL. Is not that a lesser depth of embedment than some of the other towers have, including some in the Gulf of Mexico?

EMBEDMENT OF LEGS ON TOWER NO. 4 MORE THAN ADEQUATE

Mr. RUTLEDGE. Towers No. 2 and No. 3 have no underwater bracing, sir, and the legs have to be held or fixed against rotation by the sand gripping them around the bottom, like I'm holding the pencil and pushing on the top.

Here the bracing prevents the rotation—the truss prevents the rotation of the legs, and the embedment has to resist only a horizontal push of the waves.

The depth of the embedment was quite adequate for that.

Senator SALTONSTALL. So that the depth under the ground, in your opinion, was satisfactory?

Mr. RUTLEDGE. Yes, sir.

Senator SALTONSTALL. To carry out the design?

Mr. RUTLEDGE. Yes, sir.

Senator SALTONSTALL. Thank you.

Senator STENNIS. Thank you, Senator.

Mrs. Smith?

Senator SMITH. Mr. Chairman, I think my questions will be answered through the questioning of counsel, and I yield to him.

Senator STENNIS. I yield back to the counsel, and you may proceed, Mr. Counsel.

TYPE OF CONNECTION FOR THE BRACES IMMATERIAL TO USE OF KUSS PATENT

Mr. KENDALL. Mr. Kuss, in your tip-over method of erection, I believe that it was necessary to use pin connections; is that correct?

Mr. KUSS. No, sir.

Mr. KENDALL. Could you have used a welded connection in your tip-over method?

Mr. KUSS. Yes. As far as the patent is concerned, any kind of a connection could have been used.

Mr. KENDALL. We have had testimony here to the effect that the use of welds raised the probability that upon the tip-over, the thing would fly apart or break; is that correct?

Mr. KUSS. There is no foundation to that.

Mr. KENDALL. What was the determining factor in using the pin connections?

Mr. KUSS. We used the pin connections for several reasons. In the first place, a pin connection is pretty standard for all big trusses, such as for railroad bridges and structures of that type, of unusual size.

Welded connections, if we did want to use them, would have to be much larger in dimension and be rigid.

Now, that rigidity causes what we call secondary stresses. In other words, there would be bending in the connections at the ends. For a fine type of structure like this, we thought that secondary bending should be eliminated. Any extra stresses we would get by welding would be in welded details.

Now, the other reason for the pins is that the stresses in the members are much more accurately determinable with pins because it reduces a great number of unknowns in the structure, so that we can compute the stresses much more accurately.

Now, these pins cost money. We weren't trying to get a cheap tower, but we thought it was the best connection we could devise.

Mr. KENDALL. Do I understand that you don't consider it essential that the undersea braces be as rigid as possible?

Mr. KUSS. Yes, sir; in the sense I'm talking about. We did not want to have bending moments at the end of the struts where they connect to the legs, because that introduced unknown stresses which would be repeated with every motion of the tower.

Mr. KENDALL. Wasn't it essential that the undersea braces be as rigid as possible?

Mr. KUSS. Sir, I'm talking about the individual braces. Rigidity does not mean strength, sir, necessarily. Strength is one thing and rigidity is another.

Mr. KENDALL. Well, didn't you want to establish as great a rigidity as possible in the undersea braces?

Mr. KUSS. No, sir. We were purposely avoiding rigidity at the ends of the members.

Mr. KENDALL. What do you mean, at the ends of the members?

Mr. KUSS. Where each member connects to the legs or where they connect to one another.

Mr. KENDALL. Where did you want to achieve your rigidity?

FUNCTION OF TRUSSED SYSTEM

Mr. RUTLEDGE. Sir, the truss system, as in any truss, provides the rigidity of the structure. Mr. Kuss is discussing the joint. The overall rigidity is provided by the truss. This is similar to a very large bridge. To our knowledge, in the main connection joints in a large bridge, completely welded connections have never been used. The connections or major members are either pinned or riveted or bolted.

Mr. KENDALL. I am anxious to get the distinction, Mr. Rutledge.

Mr. RUTLEDGE. I beg your pardon?

Mr. KENDALL. I am anxious to get the distinction that you have mentioned.

Mr. RUTLEDGE. Well, the rigidity—we need rigidity in the overall structure against lateral forces. The system of bracing members provides that rigidity.

On the other hand, the joint where these members come together, if they are completely rigidly connected at the joint and there is a very small deflection, it tends to bend each of the members at the joint, which puts in what is called the secondary stresses.

Mr. KENDALL. Now, as the architect-engineer, were all the changes which deviated from the original design approved by your firm?

CHANGES APPROVED BY ARCHITECT-ENGINEER

Mr. RUTLEDGE. They were approved as they affected the ultimate structure.

Mr. KENDALL. Was the elimination of piling approved?

Mr. RUTLEDGE. Yes, sir.

Mr. KENDALL. The elimination of the temporary platform?

Mr. RUTLEDGE. Yes, sir.

Mr. KENDALL. The increases in pin tolerances?

Mr. RUTLEDGE. We were asked by Commander Foster for our advice on the pin tolerances. The contractor had requested that the specified tolerances be increased to the standard tolerance for this type of construction, and we finally agreed that it could be increased to the standard, which was one-sixteenth of an inch.

Mr. KENDALL. And one-eighth of an inch on the upper braces which were to be lashed down?

Mr. RUTLEDGE. Yes, sir. Those pins, because of the method of construction elected by the contractor, those pins had to be placed under water.

Mr. KENDALL. Didn't that increase in the pin tolerances make it even less rigid and permit additional motion?

Mr. RUTLEDGE. We computed the motion that could be contributed by such pin tolerances, and the result is in the order of four-tenths of an inch horizontal motion at the top.

Mr. KENDALL. At the top of the platform?

Mr. RUTLEDGE. Yes, sir.

Mr. KENDALL. Mr. Brewer testified that Mr. Kuss told him the tower could move as much as 2 inches without taking up the known pin tolerances.

Mr. Kuss, is that correct?

Mr. KUSS. Mr. Brewer made a misstatement there. He said that Mr. Kuss computed this. Now, I was in attendance at the meeting with Mr. Brewer, and we were having very general conversations. He said, "Mr. Kuss, how much do you think the tower will move?"

At that time I had no figures whatsoever, and I told him 2 inches. My computations consisted of kind of waving a piece of chalk at the blackboard. It was purely a guess.

Mr. KENDALL. It was a conservative guess, was it not? Didn't the studies show it moved as much as 3 inches?

Mr. KUSS. His studies did, but we don't know that that was as a result of pin tolerances or what.

Mr. KENDALL. It was platform movement, though?

Mr. KUSS. Yes.

Mr. KENDALL. If the pilings were considered necessary to a depth of 48 feet at the time of the design of the tower, why is it that they became unnecessary a few months later?

Mr. RUTLEDGE. Sir, for foundations, it is quite common to have caissons as an alternate to piles. We had 21 piles at the base of each leg.

Mr. KENDALL. Forty-eight feet in depth?

Mr. RUTLEDGE. I believe that they were to be 60 feet. These were replaced by caissons 25 feet in diameter, and the original contemplated depth was 20 feet embedment, and we analyzed this completely.

The effect of the caisson 25 feet in diameter with full bearing, embedded 20 feet, was completely identical to the piles. For this reason we approved the contractor's request to change.

Mr. KENDALL. What was the original embedment of the caissons?

Mr. RUTLEDGE. Twenty feet.

Mr. KENDALL. Did you increase the embedment when you eliminated the pilings, or just what did you do to compensate for the elimination of the pilings?

Mr. RUTLEDGE. There was no embedment at the base of the legs, or no enlargement at the base of the legs, with piles.

Mr. KENDALL. That is the point I had in mind, sir, that I wanted to clear up.

Mr. RUTLEDGE. The legs sat on the ocean bottom, with a small ring through which the piles penetrated and fastened the piles to the leg. Then when the contractor requested a change from piles to caissons, we computed a range of possible combinations of required diameter and required depth of embedment to accomplish the same result, and gave this to him, from which he selected the 25-foot diameter and the 20-foot depth.

ELIMINATION OF PILINGS

Mr. KENDALL. Now, the elimination of the piling, I believe, sort of resulted in a chain reaction of changes, did it not? The result of the elimination of the piling made possible the elimination of the temporary platform, is that correct?

Mr. RUTLEDGE. No, sir; these were independent changes. The contractor first requested to shift from piles to caissons because he felt that he would have difficulty driving the piles. Then he later requested that the temporary platform be eliminated and that he be permitted to use the permanent platform in lieu of the temporary platform.

Mr. KENDALL. Yes, sir; but didn't he say that we do not need the temporary platform because we have eliminated the driving of the piles?

Mr. RUTLEDGE. No, sir; that was not the reason. He still had——

Mr. KENDALL. That was not one of the reasons?

Mr. RUTLEDGE. He still had to sink caissons and place concrete in them, which was a factor——

Mr. KENDALL. The fact that you eliminated piles did not contribute in any way to the elimination of the temporary platform?

Mr. RUTLEDGE. To me, these are completely independent.

Mr. KENDALL. Mr. Kuss, what do you say?

Mr. KUSS. I would say they are independent.

Mr. KENDALL. The elimination of the temporary platform did lead to the lashing down of the braces during the tow, didn't it?

Mr. RUTLEDGE. That was one of the consequences. The adding of the caissons added 20 feet to the length of the legs. That meant that when the foundation structure was placed on the ocean bottom, the braces at minus 25 feet would be 20 feet higher, or minus 5, 5 feet below sea level.

Then when he wished to use the main platform in lieu of the temporary platform, the main platform weighed something over 4,000 tons, and had a draft of about 11 feet. So that in order to use the main platform for construction, he had to fold these braces down.

Mr. KENDALL. And that brought about a situation which you originally intended or attempted to prevent; that was the making of connections under water?

Mr. RUTLEDGE. Yes, sir; because this is a difficult construction operation. However, our responsibility in terms of our contract was in terms of the ultimate structure, and his proposal, if carried out completely, would result in the same ultimate structure.

Mr. KENDALL. But that did compel you to face the problem of connecting these braces under water, which you originally set out to obviate?

Mr. RUTLEDGE. It compelled the contractor to face this problem, sir. We did not face it.

Mr. KENDALL. But you approved that change?

Mr. RUTLEDGE. The ultimate structure would be the same by this method.

If he produces the same ultimate structure, we actually cannot, without getting into serious trouble, we cannot disapprove, if there is no effect on the ultimate structure.

Mr. KENDALL. Let's see if I understand you. To do so, I will ask whether or not you approved the elimination of the temporary platform, substitution of the permanent platform, and the lashing down of the braces during the tow?

Mr. RUTLEDGE. We approved the basic construction methods that the contractor proposed to use.

Mr. KENDALL. Well, does that mean you're answering my question yes or no?

Mr. RUTLEDGE. Your question includes items which we did not approve, which were part of the contractor's responsibility.

Mr. KENDALL. I'll take them one at a time, then, sir.

Did you approve the elimination of the temporary platform?

Mr. RUTLEDGE. Yes, sir.

Mr. KENDALL. Did you approve the substitution of the permanent platform?

Mr. RUTLEDGE. Yes, sir.

LASHING DOWN OF UPPER BRACING DURING TOW

Mr. KENDALL. Did you approve the lashing down of the upper bracing during the tow?

Mr. RUTLEDGE. No, sir.

Mr. KENDALL. Why didn't you?

Mr. RUTLEDGE. Because this was not a matter that affected the ultimate structure and it was not our responsibility.

Mr. KENDALL. Did you approve a method which was submitted by the contractor showing exactly how the braces would be lashed down during the tow?

Mr. RUTLEDGE. We approved a drawing as affecting the ultimate structure, and it so states on our approval, that it is approved with respect to the permanent structure.

Mr. KENDALL. But you did approve the method submitted with some modifications that your firm made, is that right?

Mr. RUTLEDGE. Only as the method affected the ultimate structure.

Mr. KENDALL. Didn't you give a letter of approval of the method of lashing down the braces, with some modifications that your firm made?

Mr. RUTLEDGE. The approval is stamped on the drawing, sir, which says:

"This drawing is approved with respect to the ultimate structure."

Mr. KENDALL. Well, why did you suggest some changes in it, then?

Mr. RUTLEDGE. There was a series of events here because there was a year's delay in the actual construction of this structure. During this period there was a large amount of indiscriminate welding to the members, and in the course of the actual fabrication, we disapproved unnecessary welding to any of the permanent members.

Mr. KENDALL. So you did suggest some modifications of his scheme and told him to do it in another way?

Mr. RUTLEDGE. No, sir; we did not tell him do it this way. We told him——

Mr. KENDALL. You suggested that he do it this way?

UNNECESSARY WELDING TO BE ELIMINATED

Mr. RUTLEDGE. No, sir. We told him that welding, unnecessary welding to the permanent members, would have to be eliminated.

Mr. KENDALL. Did you give him a letter on that?

Mr. RUTLEDGE. We sent a marked drawing. I don't recall a letter, sir.

Mr. KENDALL. Let's go back just a minute, Doctor.

Mr. RUTLEDGE. Yes.

Mr. KENDALL. When you eliminated the temporary platform or approved the elimination of the platform you did that?

Mr. RUTLEDGE. Yes, sir.

Mr. KENDALL. You approved the substitution of the permanent platform?

Mr. RUTLEDGE. Yes, sir.

Mr. KENDALL. You knew then, at that stage, that that would necessitate the lashing down of the upper braces, did you not?

Mr. RUTLEDGE. We knew that the upper braces would have to be folded down; yes, sir.

Mr. KENDALL. Therefore, when you approved the substitution of the permanent platform for the temporary platform, you approved the lashing down or folding down of those braces?

Mr. RUTLEDGE. We knew that they had to be folded down. Getting them to the site and getting them in the ultimate design position was the contractor's responsibility.

Mr. KENDALL. But if you had knowledge of the fact that they had to be folded down when you approved of the substitution of the permanent platform, you're not suggesting that that didn't constitute an approval of the folding down of those braces, are you?

Mr. RUTLEDGE. No, sir. We knew that the braces had to be folded down.

Mr. KENDALL. And in practical effect, you approved it?

Mr. RUTLEDGE. Of the folding down; yes, sir.

Mr. KENDALL. Mr. Rau testified last week that you further approved the submitted method of lashing down, and later changed that method. Is that true?

Mr. RUTLEDGE. It is true that there is a drawing in 1956 for the lashing down, which is stamped approved with respect to the permanent structure.

Subsequent to that drawing, during the actual erection of the structure, because of a large amount of indiscriminate welding to the permanent members, we issued an advice to the officer in charge of construction that all indiscriminate welding, temporary welding to permanent members, should be eliminated.

Mr. KENDALL. Which members of your firm were out at the site when the tower was towed for erection, and at the time it was determined that there was damage to the lashed down braces?

Mr. RUTLEDGE. Our resident engineer for the borings, Mr. Barry Englander, was on the platform during the tow out. I personally arrived at the site with Mr. Steers at midnight of the day that the foundation structure had been rotated to a vertical position, and when we arrived, the foundation structure was in the vertical position.

DAMAGE TO BRACES DISCOVERED

Mr. KENDALL. And the damage to the braces had then been discovered, I assume?

Mr. RUTLEDGE. So I learned later.

Mr. KENDALL. Was Mr. Kuss there then?

Mr. RUTLEDGE. No.

Mr. KENDALL. Did you or any member of your firm have any discussions about what was the proper thing to do then about the lost braces?

Mr. RUTLEDGE. When Commander Foster transferred from the foundation structure to the platform on the afternoon of the following day after we had arrived at around midnight, the foundation structure had been placed in the correct position and had been lowered down to the ocean bottom so it was setting on the ocean bottom, and the party who were on the foundation structure then came to the platform.

Commander Foster then told me about the loss of the two braces, and we discussed the situation.

Mr. KENDALL. Did you consider that a serious mishap or defect?

Mr. RUTLEDGE. We considered this as serious. We considered it particularly serious during the construction period.

We discussed possible correction and we believed that replacement braces could be designed that would serve the function of the lost braces.

Mr. KENDALL. Was there any discussion of the possibility of taking the tower back to port for repairs?

Mr. RUTLEDGE. That entered into our discussions and considerations. The upending and placing into position had been difficult and hazardous, as all operations at sea are.

This was a consideration. We considered that if we took it back to port, there would be a year's delay in the construction of this entire structure, for which there was considerable pressure, and we felt it would be possible to design and have installed adequate replacements. In considering all of these factors——

Senator STENNIS. Will you suspend right there just a minute, Dr. Rutledge?

(Brief recess.)

Senator STENNIS. All right, gentlemen. May we have quiet, please?

May I say this, gentlemen: Your references to the tower model as you point out various parts of the structure are quite helpful to us. I think if you would just put the model over closer to you, about where the water pitcher is, it would be so much more convenient to you.

Then you can use your pencil as a pointer. I am sorry we do not have a long pointer. It would save a lot of time, as well as make it more convenient to you.

Proceed, gentlemen.

Mr. KENDALL. Had you completed your answer to that question, Mr. Rutledge?

Mr. RUTLEDGE. Frankly, I have forgotten the question and I have forgotten my answer.

Mr. KENDALL. I think we'll get back into it.

As I understand it, the representative of the Navy, Commander Foster, and yourself, and a representative of the contractor participated in these discussions; is that correct?

Mr. RUTLEDGE. My discussions were separately with Commander Foster, sir.

Mr. KENDALL. You had no discussions with any representative of J. Rich Steers, Inc.?

Mr. RUTLEDGE. I was present at a subsequent discussion. I had no part in the discussion.

Mr. KENDALL. Did you have any recommendation or did you express an opinion as to what should be done?

Mr. RUTLEDGE. I did, to Commander Foster.

Mr. KENDALL. What was your recommendation?

Mr. RUTLEDGE. I told Commander Foster that I believed that replacement braces that would accomplish the result of the lost braces could be designed.

REPLACEMENT BRACES DESIGNED

Mr. KENDALL. Were they designed?

Mr. RUTLEDGE. Yes, sir.

Mr. KENDALL. Who designed them?

Mr. RUTLEDGE. We did.

Mr. KENDALL. What generally did they consist of?

Mr. RUTLEDGE. It consisted of two braces of the same size that utilized the existing pin connections at elevation minus 25 feet [indicating], that were fastened to the legs by collars above elevation minus 75 feet, because the connections at minus 75 feet had been broken in the loss of the two original braces.

Mr. KENDALL. So your firm was responsible for the design of the collar replacement and the use of the Dardelet bolts; is that right?

Mr. RUTLEDGE. We did this work for the contractor and were paid by the contractor for doing it.

Mr. KENDALL. But the design was your responsibility?

Mr. RUTLEDGE. We designed them for the contractor; yes, sir.

Mr. KENDALL. We have had some testimony here to the effect that Dardelet bolts are usually used for temporary repairs. What is your judgment?

Mr. RUTLEDGE. Dardelet bolts are used, I believe, just as frequently for permanent structures as for temporary.

Mr. KENDALL. Nonetheless, in this particular case, it developed that they did not hold; is that not true?

Mr. RUTLEDGE. It developed that they did not hold, for reasons that I believe Mr. Crockett has presented to this committee.

Mr. KENDALL. In any event, if the lashings had held during tow, you wouldn't have been faced with the problem of the use of Dardelet bolts at all?

Mr. RUTLEDGE. That is right, sir.

Mr. KENDALL. Well, going to the early part of 1960, I believe that there was a report that a diver examination had revealed loose pins and worn connections in the underwater bracings at elevations minus 25 feet and minus 75 feet; is that right?

WORN CONNECTIONS IN BRACES CONSIDERED SERIOUS

Mr. RUTLEDGE. Yes, sir; Mr. Kuss attended a meeting at Otis Air Force Base where that report was presented.

Mr. KENDALL. Did you consider that a—possibly I should direct this question to Mr. Kuss.

Mr. Kuss, did you consider that a serious consideration?

Mr. KUSS. Well, it looked quite serious, for the reason that this looseness had developed in such a short time since the last diver inspection. It was quite mysterious to me and somewhat alarming. If it had happened over the 4-year period that the tower was up, it wouldn't have been so puzzling. But there was about an 8-month gap between the divers' report that everything was tight and this report that designated loose pins.

Mr. KENDALL. Was it your opinion, Mr. Kuss, that the situation was so serious that if it wasn't corrected, it would worsen at an accelerating rate and raise a serious question as to the safety of the tower?

Mr. KUSS. As I said, because of the uncertainty of what was causing this apparent rapid loosening of the pins, it could have been quite serious. We were alarmed.

Mr. KENDALL. Well——

Senator STENNIS. Pardon me, let's put a date on that. You perhaps did already, Mr. Counsel.

When was it, now, that you are talking about there, Mr. Kuss, when you say, "We were alarmed"? An approximate date?

Mr. KUSS. This is February 1960. I don't have the day; February 1960.

Mr. KENDALL. You did write two letters with reference to the problem, didn't you, Mr. Kuss, one dated April 1, 1960, to Major Phelan?

Mr. KUSS. Yes, sir.

Mr. KENDALL. And you stated in that letter that the "loose pin connections are a very serious matter since there seems to be no way of satisfactorily remedying this condition." Is that right?

Mr. KUSS. That's right.

Mr. KENDALL. And furthermore, "that the condition was one that would tend to worsen at an increasing rate with time?"

Mr. KUSS. It couldn't do anything but increase; yes. The condition could not get better. It would increase, if anything.

Senator STENNIS. Were you reading from the letter, Mr. Counsel?

Mr. KENDALL. Yes, sir.

Senator STENNIS. This is Mr. Kuss' letter?

Mr. KENDALL. Mr. Kuss' letter to Maj. James Phelan. We would like to have a copy of this letter made a part of the record, Mr. Chairman.

Senator STENNIS. It is so ordered.

(The letter referred to is as follows:)

MORAN, PROCTOR, MUESER & RUTLEDGE,
New York, N.Y., April 1, 1960.

Re motion of Texas tower No. 4 and condition of bracing connections.

Maj. JAMES PHELAN,
Commander, 4604th Support Squadron (TT),
Otis Air Force Base, Mass.

DEAR SIR: As a result of the diver inspection of the underwater bracing between the legs of Texas tower No. 4 and from reports of experience of personnel on the tower, we wish to make comments and recommendations.

The diver's findings were reported to Air Force representatives in a meeting at Otis Air Force Base on February 9, 1960, and subsequently the findings were summarized on a drawing prepared by the Air Force and titled "Underwater Structural Deficiencies, Texas Tower No. 4" (drawing OTS–140–061), dated February 11, 1960. The findings indicate that on the A–B side there are loose pin connections on all of connections of the horizontal braces at elevations ±25 and ±76. Also the main bolts of the collars connecting replacement braces to the legs just above elevation ±76 are not tight.

The loose pin connections are a very serious matter since there seems to be no way of satisfactorily remedying this condition. Furthermore, the condition is one which will tend to worsen at an increasing rate with time. This is because the looseness induces impact stresses in the pins and pin plates which are greater than for the nondynamic design assumptions and will become increasingly greater as the play in the joint enlarges.

There are no circumstances which would tend to alleviate these conditions if corrective measures are not undertaken. Due to the complexity of the pin connections (multiplicity of plates involved, etc.), there seems to be no practical way of restoring the defective connections to their originally conceived condition. It would be exceedingly dangerous to remove the pins for replacement. Even if the pins could be removed, however, it would be necessary to ream the holes to a larger circular shape to fit new oversize pins and we believe this to be impossible. After careful and long consideration we have concluded that the only practical cure for the situation is the addition of new above-water braces which we have advocated and designed. We recommend this type of bracing for all three sides because the requirement of their being entirely above water does not provide an ideally effective depth and the bracing on the A–C and B–C sides reduces bending components from these sides almost to zero, thus increasing the factor of safety in the A–B system. The bracing on the three sides will also reduce the general motions of the tower, including rotation and will diminish the tendency to develop impact on all of the bracing pins, including those which have not as yet shown any distress.

Time is of the essence in the program for erecting new braces. The hurricane season has been pretty well established as beginning after the first week of August and the schedule for construction to be reasonably sure of accomplishment should be essentially complete by that time. If the new braces are not secure by then and are lost due to hurricane action the tower would be forced to undergo another winter's exposure and it is very doubtful if the deteriorating pin connections will survive. This means that a contract should be let immediately so that fabrication can be started by May 1. Allowing 5 weeks for fabrication and 8 for erection brings the completion date to the beginning of the danger period.

Due to the above-discussed urgency, and the contingencies inherent in the type of construction involved, it would appear that a cost-plus-fee contract would be most ideal for the accomplishment of the work. This would permit the Government to assume the hazards which would otherwise be generously included as contingencies in competitive bidding. It would enable the Government to ask for extra expediency measures, if necessary, and it would permit the Government to negotiate with the contractor who built the tower (J. Rich Steers Co.) and who is most familiar with all of the conditions attendant upon the work.

We trust that the foregoing makes our position clear, but will be glad to furnish further information if desired. As you are aware, we have made every effort to expedite the plans and specifications pending a formal A. & E. contract and these are now available for initiating the work.

Very truly yours,

MORAN, PROCTOR, MUESER & RUTLEDGE,
By THEODORE M. KUSS.

Mr. KENDALL. You also wrote a letter, I believe, dated August 10, 1960; is that right?

Mr. KUSS. To whom was that, sir?

Mr. KENDALL. That is to the base procurement office, Otis Air Force Base.

Mr. KUSS. We'll have to check that.

LOSS OF TOWER PREDICTED

Mr. KENDALL. That is a letter in which you enclosed your report on your analysis of the existing damage.

Mr. KUSS. Yes, that is this one [indicating], yes, sir.

Mr. KENDALL. And in that report, you again stated:

> The looseness of the pins will in all probability continue to worsen, at perhaps an accelerating rate, since the sloppiness contributes to the magnitude of the impact stresses on the connections and the increased impact in turn aggravates the wear in the joints. It was therefore concluded by our office that it would be hazardous to permit the conditions to remain uncorrected through any more winter seasons, with the ultimate loss of the tower being the possible result of such neglect.

Mr. KUSS. Yes, sir; that's in the report.

Senator STENNIS. You wrote that letter, Mr. Kuss, on the date indicated by counsel; is that correct?

Mr. KUSS. August 10, yes.

Senator STENNIS. You say that is your letter?

Mr. KUSS. Yes; this is a report.

Mr. KENDALL. We would like for the letter and the report to be a part of the record.

Senator STENNIS. It will be so ordered, and counsel, in order to get these facts in mind as they are developed, I would like to see the first letter you introduced and the second one, too. I shall glance at it, at least, as soon as these gentlemen finish.

(The document referred to is as follows:)

MORAN, PROCTOR, MUESER & RUTLEDGE,
New York, N.Y., August 10, 1960.

Subject: A. & E. contract AF19(603)–708

BASE PROCUREMENT OFFICE,
Otis Air Force Base, Mass.

(Attention: Capt. B. A. Grassfield)

GENTLEMEN: In accordance with the terms of the subject contract, we herein submit our report on the analysis of the existing damage and recommended emergency repairs to Texas Tower No. 4. At the time of this writing, the emergency repair work has been completed and a description of the actual work as performed in the field will be described in a report to be prepared by our firms under the terms of our title II contract covering the field supervision of the construction work.

Very truly yours,

MORAN, PROCTOR, MUESER & RUTLEDGE,
THEODORE M. KUSS.

REPORT ON DESIGN OF BRACES AND SPECIFICATIONS FOR EMERGENCY REPAIR WORK, TEXAS TOWER NO. 4

INTRODUCTION

Diver examination, in the early spring of 1960, of the underwater braces of Texas tower No. 4 revealed conditions which are summarized on drawing No. OTS–140–061 issued by the Otis Air Force Base and titled, "Underwater Struc-

tural Deficiencies." This summary shows the existence of loose pin connections on the A–B side for all of the pins at elevations −25 and −76. This looseness permits excessive oscillations of the tower resulting in annoyance to the personnel on the tower and causes concern as to the ultimate safety of the structure. The looseness of the pins will, in all probability, continue to worsen at, perhaps, an accelerating rate since the sloppiness contributes to the magnitude of the impact stresses on the connections and the increased impact in turn aggravates the wear in the joints. It was, therefore, concluded by our office that it would be hazardous to permit the conditions to remain uncorrected through any more winter seasons, with the ultimate loss of the tower being the possible result of such neglect. Statements of our conclusions were contained in a letter from our firm to the Air Force dated April 1, 1960. In that letter we recommended the installation of additional braces between the legs above the water on all three sides.

POSSIBLE CORRECTIVE MEASURES

The choice of schemes for correcting the deficiencies are limited and, from the point of view of cost and practicability of accomplishment within the summer season of 1960, the placing of the braces proposed offers the only satisfactory answer. The seemingly obvious solution of repairing the pin connections had to be rejected because of the complexity of the connections and the inaccessibility of the inner pin plates. All of the defective connections are underwater which makes any reliable repair work, especially that involving welding, almost impossible. In addition, there is motion in the joints at all times and no practical means could be suggested which would eliminate this motion while repairs were attempted. All work of assembling and attaching the proposed braces will be above water and the work will be capable of being inspected at all times during installation and afterward.

DESIGN CRITERIA

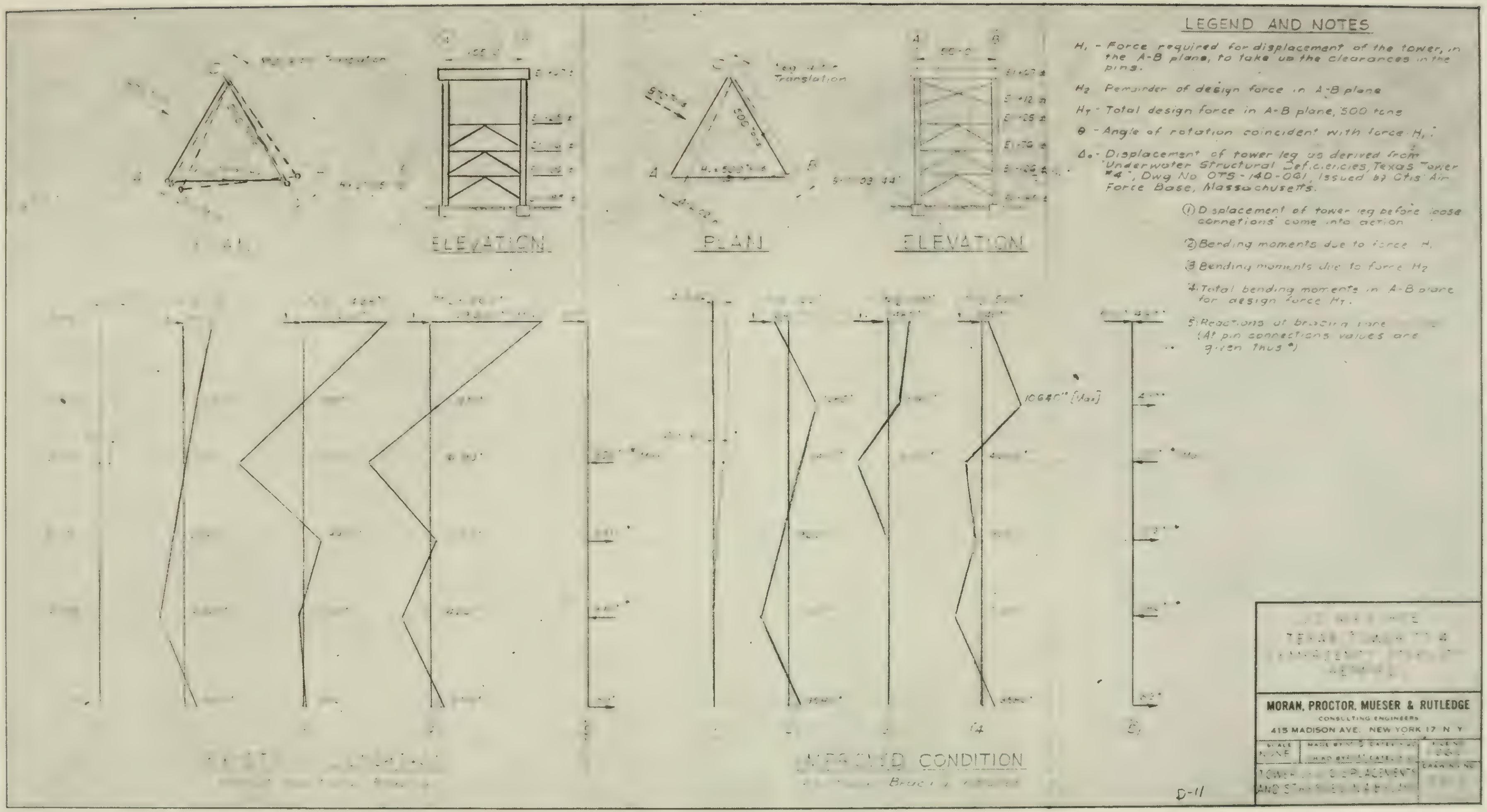
The original design of the tower was based on the action of a 35-foot breaking wave combined with a 125 mile per hour wind. The behavior and strength of the tower with the new proposed braces was analyzed for the same forces.

BEHAVIOR OF TOWER

The diver survey indicates that the pin connections are in a satisfactory condition on the B–C and A–C sides so that the discussion which follows, and which is illustrated on attached SK–1, applies to the A–B side only. The forces indicated and discussed are those resulting from the portion of the total applied force taken in the A–B plane.

The behavior of the A–B system with moments in the legs and reactions at the bracing points is shown on SK–1 for both the present condition and the condition after the new bracing is installed. It is assumed, in each case, that before the loose connections take up, the system acts as a portal frame supported at the lower end at elevation minus 126 feet (the first level at which the pins are tight). Because of the improved stiffness of this portal system with the new braces installed, the magnitude of the lateral force taken by the portal before the original bracing system is called into action is much greater than for the existing condition. After the original bracing comes into action the proportion of the total load taken into the damaged pin connections will be much less for any given wind and wave load. As a result of introducing the new braces, moments in the legs and forces on the existing bracing are changed as follows:

1. The maximum moment in a leg is reduced from 29,600 foot kips applied at elevation plus 67 to 10,640 foot kips applied at elevation plus 12.
2. The horizontal force on the existing bracing is reduced from 850 kips at elevation minus 25 to 556 kips at the same elevation. It is to be pointed out that these figures are, to a certain extent, qualitative since the computations are based on an estimated 1.6-inch deflection at elevation minus 25 before the existing braces come into action. The deflection is derived from the diver's estimate of the play in the pins. If the pins are in reality less sloppy than estimated, this is all to the good but in any case if the wear in the pin connections increases, the more beneficial the new braces become.



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It is to be noted that the above computations are for static loading assumptions. A comparison of dynamic effects would probably show comparatively greater resulting benefits because of the decreased amplitude of the oscillation and also because the natural period of the structure will be decreased, making it less likely to coincide with that of the larger waves.

A byproduct of the new installation is a diminished angle of rotation of the platform in the horizontal plane. Although the introduction of braces on the B–C and A–C sides was principally for the purpose of giving lateral support to the A and B legs at the points of maximum moment stress, these braces also contribute to (1) the general stiffness of the tower, (2) diminish the angle of rotation, and (3) further decrease possible future wear of pin connections on the A–C and B–C sides.

OTHER WORK SPECIFIED

In addition to the preparation of drawings and specifications for the fabrication and erection of the braces, there was also specified certain other work to be undertaken at the same time and under the same construction contract. This included:

(1) Torque testing of all of the bolts in the collars which attach the lower ends of the upper diagonals to the main legs on the A–B side. These included the 1¼-inch-diameter T-bolts and the 2-inch-diameter main collar bolts. The former were to be torqued to 1,200 foot-pounds and the latter to 1,400 foot-pounds. With these applied torques no turning of the nuts was reported.

(2) Testing of bolts in the K-braces between the tower platform and the main legs to a torque of 700 foot-pounds was specified. A few bolts turned under this torque.

(3) Magnafluxing of the welding of the K-braces to the platform and of the lower deck plate to the legs was specified. No defects were found in this welding.

(4) Further and more complete examination of the loose pins at elevation —26 was specified in the construction contract. This involved removal of the keeper plates at one end of each of the four pins and measurement of the play between the pins and the pinholes, all to be verified by underwater photographs. In general the play was found to be less than estimated on the previous, less thorough, examination and appear to be a maximum of about one-half inch.

A complete report on the findings will be rendered under the terms of our title II contract covering the supervision of the construction work.

FUTURE PRECAUTIONS

As to future precautions and inspection of the tower structure, we consider it advisable to examine all of the new bracing connections at intervals of not more than 1 month or after each relatively heavy storm. The main purpose of such examination would be to discover any cracks, large or small, which may have developed in the welds or plating. At the same time the 1¼-inch-diameter high-tensile bolts of the new braces should be examined by jarring with a hammer as is done in a rivet test.

We do not believe that it will be necessary to test any of the old bolts on the underwater collars or the K-brace platform connections unless a very severe storm approaching design conditions has occurred. In such event we recommend that the K-brace bolts be given a rivet type test.

Respectfully submitted.

MORAN, PROCTOR, MUESER & RUTLEDGE,
THEODORE M. KUSS.

Senator STENNIS. All right, proceed.

Mr. KENDALL. Is that when you recommended the installation of the above-water braces?

Mr. KUSS. Yes, sir.

Mr. RUTLEDGE. Sir, this was a confirmation of the recommendation which had been made in May or June.

Mr. KENDALL. And they were installed in August 1960?

Mr. RUTLEDGE. Installation was completed shortly after the 1st of August 1960.

Mr. KENDALL. Was a complete stress reanalysis made before making that recommendation?

Mr. KUSS. Oh, yes, sir.

Mr. KENDALL. Do you have a copy of that?

Mr. KUSS. The stress analysis is in the report.

Mr. KENDALL. That is all right, if it is in the report.

Mr. KUSS. Here is a sheet showing the stresses before and after the installation.

Mr. KENDALL. Weren't the braces and the pin connections at the minus 25-foot and minus 75-foot level in bad shape at that time?

Mr. KUSS. They looked to be, sir.

Mr. KENDALL. Well, wasn't it considered necessary to effect a repair of those braces?

Mr. KUSS. Yes, sir, if possible.

Mr. KENDALL. Was it done?

Mr. KUSS. No, sir. I would like to give you a little history of this, right here.

Mr. KENDALL. Yes, sir, go right ahead.

Mr. KUSS. At our meetings with the Air Force, when it was decided to put the above-water bracing on, we all agreed that something would have to be done to the pins ultimately, but the way the tower stood, it would have been impossible or very dangerous to remove the pins, as, for instance, to put in larger ones. We felt if we could secure the tower with the above-water bracing, then, when the weather was suitable, we could go after the pins and do something to them.

DIFFICULTY IN EXAMINING PINS

Now, along those lines, when the contractor was erecting the above-water bracing, it was provided in his contract that he examine those pins, reexamine them well—that is, better than they had been examined before. That meant taking off the washers at the ends of the pins so that you could actually see the relationship of the hole to the pin. That was part of the contract he had. We had no information on the true condition of the pins, because the previous divers had always had to contend with the fact that there was a plate which covered the hole. So although we knew the pins were loose, we did not know the exact conditions. We couldn't combat it until——

Mr. KENDALL. You knew the braces were ineffective, didn't you, Mr. Kuss?

Mr. KUSS. They were not ineffective.

Mr. KENDALL. Well, they were not working properly.

Mr. KUSS. Yes, they were not working properly.

Mr. KENDALL. I take it you do not agree with the statements that have been made in the record that the installation of this above-water X-bracing, without correction of the difficulties in the undersea bracings, caused the tower to act like a huge hinge?

Mr. KUSS. No, sir, I don't understand that.

Mr. KENDALL. You don't understand it or you don't agree with it, which, or both?

Mr. KUSS. I don't agree with it.

Mr. KENDALL. How long would it take to make a stress reanalysis of this tower?

TIME REQUIRED TO COMPUTE STRESS REANALYSIS

Mr. Kuss. Of the stress in the various members, you mean?

Mr. Kendall. Yes, sir; such as you made in connection with the installation of the above-water X-bracings.

Mr. Kuss. Well, for each different condition, each different problem, it might take a week.

Mr. Kendall. How long did the analysis that you made take?

Mr. Kuss. I would say a week.

Mr. Kendall. That is a complete stress reanalysis?

Mr. Kuss. Yes, sir.

Mr. Kendall. Of the entire tower?

Mr. Kuss. Yes.

Mr. Kendall. Now, as to the installation of this above-water X-bracing, did you certify that the tower had been restored to the original design strength?

Mr. Kuss. Yes.

Mr. Kendall. Well, how could it have been restored to the original strength when you admittedly had the deteriorated pin connections below water and braces were not functioning correctly?

Mr. Kuss. Our analysis took in the fact that the pins were loose.

Mr. Kendall. You considered, then, that it had been restored to the original design strength?

Mr. Kuss. Yes, sir.

Mr. Kendall. As a matter of fact, you put that X-bracing in the area where the impact of the waves was the strongest?

Mr. Kuss. Yes, sir.

Mr. Kendall. And that was a complete departure from the original design concept?

Mr. Kuss. From the original design, yes.

Mr. Kendall. And each storm that hit that X-bracing resulted in cracks in it, didn't it?

Mr. Kuss. I don't know that.

Mr. Kendall. Well, were there cracks in the X-bracing after——

X-BRACING SATISFACTORILY INSTALLED

Mr. Rutledge. While the X-bracing was being installed, when it was partially installed, the contractor was facing the difficulty that occurs in every welded connection, that with a partial welded connection, if a storm hits, the connection isn't strong enough to take the forces imposed and cracks occur. These occurred at least once, and possibly twice, during the installation of the above-water bracing, and these are in the record of our resident engineer who was supervising this work. When this entire bracing was completely installed, there were no cracks in any of the connections. The contractor corrected all of the cracking.

Mr. Kendall. That bracing was completely installed in August?

Mr. Rutledge. In the early part of August the work was completed.

Mr. Kendall. Well, after Hurricane Donna in September were there any cracks?

Mr. Rutledge. Yes, sir; but that was a different situation.

Mr. Kendall. After the storm in December 1960, were there any cracks?

Mr. RUTLEDGE. We have no report on that, sir.

Mr. KENDALL. Those were the only two storms of major consequence, I believe, until the one on January 15, is that right?

Mr. RUTLEDGE. We have no specific information on that, sir.

Mr. KENDALL. All right, Mr. Kuss, about the middle of November 1960, did anyone in the Air Force ask you to tell him what the remaining strength of the tower was at that time?

Mr. KUSS. Yes.

Mr. KENDALL. Who was it, sir?

Mr. KUSS. Captain Grassfield.

Mr. KENDALL. What about General Elder?

Mr. KUSS. Let me get these dates straight.

Mr. KENDALL. About the middle of November 1960, isn't it true that General Elder called you on the telephone and asked you to tell him what the remaining strength of the tower was?

ESTIMATE OF TOWER STRENGTH

Mr. KUSS. Yes, sir.

Mr. KENDALL. What did you tell him?

Mr. KUSS. This was—at that time, I refused to estimate the strength of the tower.

Mr. KENDALL. You gave him no estimate at all?

Mr. KUSS. No, sir .

Mr. KENDALL. At that time, your firm had agreed with J. Rich Steers, Inc., and the date of the agreement was October 3, 1960, to evaluate the remaining strength of the tower in terms of its original design criteria, isn't that right?

Mr. KUSS. That's right, sir.

Mr. KENDALL. Why couldn't you give him an estimate in November 1960?

Mr. KUSS. This damage was so extensive that it came completely outside the terms of what we expected to find.

Mr. KENDALL. You just told me that it would take about a week to make a stress reanalysis, and you had here about 6 weeks.

Go ahead, sir.

Mr. KUSS. I have considerable knowledge of this tower, sir, having worked with it a long time. From the conditions that were discovered, I knew without making any figures that it was very dangerous. It wasn't a matter of figuring.

Furthermore, we had no knowledge that we had a report of the total damage. It could have been more, so I didn't want to encourage anybody that it was safe in anyway. Even though I had made an analysis, it might have been based on the wrong premises.

Mr. RUTLEDGE. Mr. Counsel——

Senator STENNIS. Pardon me, let us not interrupt Mr. Kuss, if you will. He has been asked a question.

You were not through with your answer?

Mr. KUSS. I think I was through, yes.

Senator STENNIS. It did not appear to me that you were, excuse me.

All right, excuse me, Mr. Rutledge.

Mr. RUTLEDGE. May we put it on the record that we were first informed about the damage by Mr. Koch of J. Rich Steers Co. on

November 14, in our office. He had received a radio call from the tower and he transmitted this information to us, and the telephone call from General Elder was on the morning of November 16.

Mr. KENDALL. From the date of October 3, 1960, until November 14, your firm had made no stress reanalysis?

Mr. RUTLEDGE. We had no information, sir, on the damage except that the maintenance bridge had been destroyed. We hunted up the drawings for the maintenance bridge so that they could replace that.

Mr. KENDALL. Mr. Kuss, were there any other occasions when you were asked by anyone in the Air Force as to what the remaining strength of the tower was?

Mr. KUSS. I——

TOWER CONSIDERED UNSAFE

Senator STENNIS. Pardon me, Mr. Counsel. I wanted to be sure I understood Mr. Kuss.

Mr. Kuss, as I understand your testimony, you say that about November 16, 1960, when you got this additional information about the condition of the tower, even without having to make any calculations, you knew from that incomplete report although you were not certain that you had the full picture as to the damage, but from that incomplete report, you considered the tower highly unsafe and dangerous; is that right?

Mr. KUSS. With the damage reported to me, it was very serious, and it may have been more.

Senator STENNIS. Very serious. Well, now, could we make that more specific? I am not trying to put words in your mouth at all. You are the witness and you are an expert witness. But as I have understood the tenor of your testimony, it is based on this knowledge that you had, even though it might not have been complete as to all the conditions, you considered it highly dangerous; is that correct?

Mr. KUSS. Yes, sir; yes, sir.

Senator STENNIS. All right, I just wanted to be certain.

Mr. KUSS. I so told General Elder.

Senator STENNIS. Yes, I understand. That is what you then told the general. General who?

Mr. KUSS. General Elder.

Senator STENNIS. And that was November 16?

Mr. KUSS. Yes, sir.

Senator STENNIS. All right, now, Counsel, you have another date in mind. Will you proceed?

Mr. KENDALL. I'll ask you this, Mr. Kuss. At any time prior to the collapse of the tower, did you report to anyone an estimate of the remaining strength of the tower as it then stood?

Mr. KUSS. No.

Mr. KENDALL. Wasn't it possible to make an analysis between October 3, 1960, and January 15, 1961? Or from November 14, 1960, to January 15, 1961?

Mr. KUSS. I don't know as I was asked to make any analysis.

Mr. KENDALL. That is what your contract was for, Mr. Kuss. You had a contract with J. Rich Steers, Inc., dated October 3 to evaluate the remaining strength of the tower. That is true, isn't it?

Mr. KUSS. Yes.

Mr. KENDALL. And up to January 15, you hadn't given an evaluation, had you?

Mr. KUSS. Yes, sir; I had given an evaluation that it was very dangerous.

Mr. KENDALL. Is that what you call an evaluation of the remaining strength of the tower?

Mr. KUSS. Under the circumstances, that was it.

Mr. KENDALL. That is a good engineering evaluation, that it was very dangerous?

Mr. KUSS. Yes, sir.

Mr. KENDALL. But you never came up with a detailed analysis such as you have in this report, did you?

Mr. KUSS. No, sir.

Senator STENNIS. Pardon me again. While you are on this point, you used the term "very dangerous," and I think that is understood. But as I interpret it, you mean that it was just dangerous for human habitation, and that it was likely to collapse under any additional strain, is that correct?

Mr. KUSS. Yes, sir. I don't see any need for adding any figures to that. That is a conclusion.

Senator STENNIS. I understand your testimony, but I wanted to be certain I understood the element of danger to humans and the likelihood of collapse.

Mr. KENDALL. If you had given some figures, Mr. Kuss, wouldn't the Air Force have been in a better position to evaluate the weather forecasts in relation to the strength of the tower?

Mr. KUSS. I didn't want to have them do that. That would be highly dangerous and misleading, because I did not know the total damage, or couldn't be sure that I knew the total damage.

Mr. KENDALL. Finally, I believe a figure of 55 percent of the original strength was attributed to a statement made by you. What did you mean by that statement, and when was it made?

PERCENTAGE OF ORIGINAL STRENGTH ESTIMATED

Mr. KUSS. This was made on January 12 in the Steers office.

Mr. KENDALL. What did you mean by the statement?

Mr. KUSS. We were discussing the installation of the rope bracing.

Mr. KENDALL. That is what we have been referring to as the cable bracing?

Mr. KUSS. The cable bracing, here in red [indicating]. In order to evaluate whether even with the installation of that in, it would be worthwhile. I was asked to evaluate the strength of the tower after the rope bracing was in.

Mr. KENDALL. In other words, you said that after that cable had been installed but without the replacement of the lower diagonal, it would be 55 percent as strong as its design criteria?

Mr. KUSS. Yes.

Mr. KENDALL. Then at that time——

Senator STENNIS. Have you answered?

Mr. KENDALL. He said "Yes."

At the time of the collapse, since the cable bracing had not been installed, the tower was even weaker than that?

Mr. KUSS. Much weaker. It was worse than the time I told them it was dangerous.

Mr. KENDALL. It had gotten worse all the time, because you had some more damage in the December storm, or you discovered some after the storm?

Mr. KUSS. Yes, sir.

Mr. KENDALL. Do you have any judgment as to the percent of strength at that time?

Mr. KUSS. After Donna?

Mr. KENDALL. After the December storm.

Mr. KUSS. You see——

Mr. KENDALL. As of January 12, 1961, say, Mr. Kuss?

Mr. KUSS. Sir, I was almost surprised the tower stood up.

Senator STENNIS. What was that, now? You were surprised that it stood up?

Mr. KUSS. Yes, sir.

Mr. KENDALL. During what period?

Mr. KUSS. During any of the moderate weather periods that they had.

Mr. KENDALL. So you made no estimate in figures of the remaining strength of the tower and have none now?

Mr. KUSS. No, sir. You see, the percentage of residual safety is, when you are getting down to 95, you are on——

Mr. KENDALL. But the intensity of the storm during which the tower ultimately collapsed was nowhere near the design criteria, was it, Mr. Kuss?

Mr. KUSS. We don't know.

Mr. KENDALL. What is your information on that? It was an ordinary winter storm, was it not?

Mr. KUSS. I suppose, but we had no figures on that.

Mr. KENDALL. Well, it was not a storm involving winds of 125 miles an hour and breaking waves of 35 feet, was it?

Mr. KUSS. No, I don't think so.

REASON FOR COLLAPSE

Mr. KENDALL. We are faced now, Mr. Kuss, with the tower collapse, and we have several alternatives—faulty design, possibly; faulty construction; faulty repair; or a combination of all of these things.

Can you or Mr. Rutledge tell us now what made this tower collapse?

Mr. RUTLEDGE. If I may answer, sir, from information that we have heard, and I believe it was part of the testimony here, the tower during Hurricane Donna was subjected to forces that were very much in excess of the design criteria forces.

Mr. KENDALL. Does that conclude your observation on that?

Mr. RUTLEDGE. These forces of Hurricane Donna, as has been testified, broke two of the panels of bracing in the tower. With two panels of bracing completely gone, the tower was in a very dangerous condition. It definitely did not have strength to resist the design criteria, and it could resist only something very much smaller.

As Mr. Kuss has testified, it was essentially impossible and extremely dangerous to say what it could resist.

70733—61——19

Mr. KENDALL. If the forces of Donna were considerably in excess of the design criteria, then it necessarily follows, does it not, that the design criteria was inadequate?

Mr. RUTLEDGE. The design criteria were studied very carefully in terms of the information available at the time of the design. It is apparent that the storm did exceed those anticipated.

Mr. KENDALL. That is all I have, Mr. Chairman.

Senator STENNIS. Thank you very much, Mr. Counsel.

Gentlemen, I have just a few questions here.

Mr. Kuss, may I go back to a statement you made a few minutes ago? You said that you were surprised that the tower stood up, and that is when you were testifying with reference to either November 16 or the November 14 discussion, as I understood it.

Mr. KUSS. No, sir.

Senator STENNIS. No? When was it, then?

Mr. KUSS. This was after they discovered the bottom-most bracing, when all three panels were gone.

Senator STENNIS. When did that happen?

Mr. KUSS. When did they discover that these three bottom braces were gone?

Senator STENNIS. Yes.

Mr. KUSS. They discovered that when they were going down to begin to make the installation of the rope bracing. They discovered that the lower panel was gone.

Senator STENNIS. Could you give an approximate date of when this was?

Mr. KUSS. Yes, that was January 8.

Senator STENNIS. January 8?

Mr. KUSS. Yes.

Senator STENNIS. So after you learned that those facts were true, not knowing how long they had been true, then it was a surprise to you that it had been able to stand at all?

Mr. KUSS. That is right, but we do not know when this last brace broke.

Senator STENNIS. I know you don't. My question covered that. But whenever it happened, it was a matter of surprise to you that the tower could stand any further?

Mr. KUSS. Yes, sir, and you see, that is a good example of why I didn't want to give any estimates back in November, because that could have been broken then. That is typical of something you don't know.

COMPLETENESS OF EXAMINATION QUESTIONED

Senator STENNIS. You did get certain information in November 1960, but you understood then that that was a complete examination of the tower, is that correct?

Mr. KUSS. I understood then that it was.

Senator STENNIS. You understood then that it was a complete examination?

Mr. KUSS. Yes.

Senator STENNIS. With great deference to you, I thought you gave as the reason just a few minutes ago for withholding a firmer estimate was the fact that you did not think that was a complete examination.

Mr. Kuss. Sir, I gave that as an example of a fracture that might not have been discovered. I did not say that it was not in place at that time.

Senator Stennis. Well, it is probable that these braces were torn loose down there during Hurricane Donna?

I know that is highly speculative, but do you think it probably happened then?

Mr. Kuss. I don't know.

Senator Stennis. You don't know? What I am leading to is the period of reasonable notice of this situation. Was not there ample time to make a more thorough examination between November 14 and January 12? That was a period of 60 days.

Mr. Kuss. Well, sir, I was informed that the tower was given a complete examination when we got our report of November 14. I presumed that was a complete examination.

Senator Stennis. All right. Anyway, when you learned in January this lower brace was broken; that is when you were really surprised that the tower kept standing in view of that condition?

Mr. Kuss. As long as that condition was true; yes.

Senator Stennis. Yes, since it was true, since it started and as long as it continued?

Mr. Kuss. Yes.

Senator Stennis. Now, I want to ask Mr. Rutledge this question: We have had the testimony here from you and others as to what happened during the upending and the unfortunate fact that the braces were broken loose.

Now, after the tower was upended and put in place, Mr. Rutledge, did you ever approve this tower as it stood there in the water? When it was first upended, the braces were broken. Now, you did not approve it in that condition, did you?

Mr. Rutledge. No, sir.

Senator Stennis. All right. Was there any time from then on until it fell when it was in condition where you could approve it?

Mr. Rutledge. To my recollection, sir, we did not or were not requested to make any such certification, except upon the completion of the installation of the above-water X-bracing in which the Air Force requested a certification which we provided, that it was in a condition to meet the design criteria.

Senator Stennis. I understand that, Mr. Rutledge, but with all deference to you—I do not think you are being evasive or trying to be evasive, but I dont' think you answered the question.

You are a highly responsible gentleman in every way, and a highly competent one. Just as a layman, after hearing all this testimony, I can't think of any time, from the time it was first upended until it collapsed, years later, that I would think it was in top condition or in the condition for which it was designed.

Therefore, I wouldn't have approved it, as I see the testimony.

Now, you know more about it than I do. Was there a time, from the time it was upended and erected until it collapsed, that you could have approved it as it stood?

Mr. Rutledge. Yes, sir. We did not approve it. But after the slippage of the collars was corrected with the bolts, the T-bolts——

Senator Stennis. Yes.

TOWER MEETS DESIGN CRITERIA IN SUMMER OF 1959

Mr. RUTLEDGE. And the tower was inspected underwater for play of pins, in my opinion, at that stage, which was in the summer of 1959, following an inspection by Mr. Crockett, the diver, I believe the tower was in a condition equal to the design conditions.

Senator STENNIS. All right. That is very specific, and very good. That was my next question. When did it meet these conditions; in the summer of 1959 until when?

Mr. RUTLEDGE. Until we received a report of looseness of pins at the minus 25 foot elevation on the A–B side.

Senator STENNIS. Yes.

Well, now, when was that?

Mr. RUTLEDGE. Approximately 8 months later.

Senator STENNIS. Well, now, 8 months from the summer of 1959, just making a quick calculation, would be somewhere around February 1960.

Mr. RUTLEDGE. Yes, sir.

Mr. KUSS. February 14, 1960.

Senator STENNIS. That is all right. It is very clear. The condition of the tower was less than its design strength, and it never did regain its original design strength again; isn't that correct?

TOWER STRENGTH DIMINISHES

Mr. RUTLEDGE. With the addition of the above-water bracing, it had a strength equal to the design criteria, on the assumption that the replacement braces on the A–B side were defective.

The actual looseness of the pins was measured during the installation of the above-water bracing.

The actual looseness of the pins or play in the pins was in the order of three-eighths of an inch to seven-sixteenths of an inch, as measured by the divers after they took the keeper plates off, and these measurements were part of the contract which involved the above-water bracing, and the measurements are included in our report to the Air Force dated September 9, 1960, on page 2.

Senator STENNIS. All right. You know, of course, from the record that there is a conflict of evidence, as I understand it, about the extent of the looseness of those pins, and also the effectiveness of these braces. We have the testimony of Mr. Brewer, I believe, about the results of his motion study. Is that correct?

Mr. KUSS. Yes, sir.

Senator STENNIS. Do you want to address anything further to the point I brought up, with reference to the conflict in the evidence?

CONFLICT IN EVIDENCE ON EXTENT OF WEAR IN PIN CONNECTIONS

Mr. RUTLEDGE. There are two points there, sir, if I may bring them out.

Senator STENNIS. Yes.

Mr. RUTLEDGE. First, on the looseness of the pins, part of the contract between the Air Force and J. Rich Steers, Inc., for the installation of the above-water bracing was to remove the keeper-pin plates

from the pins, to make measurements of the pins, pin clearances, and to take underwater photographs of the pin clearances.

These measurements were made, the underwater photographs were taken, and the underwater photographs were supplied to the Air Force directly by J. Rich Steers, Inc., as a part of their contract.

We received the measurements, which are included in our report.

With reference to Mr. Brewer's testimony, he was testifying for conditions of waves which were far less than the design criteria conditions. The forces exerted by the waves were relatively small. The stresses measured and created were relatively small, and in my opinion, it is quite possible, under these quite small stresses, that the stresses in the underwater bracing in the truss system were so small that it didn't show much effect of the underwater bracing. His measurements do indicate when he gets to the 28 foot waves, which I believe was the highest during his measurement, that the underwater bracing was working.

Senator STENNIS. All right. I think you have made your testimony clear on that point.

So your point is that when you got the above water X-bracing installed in September 1960, this restored the tower to the original strength; is that correct?

Mr. RUTLEDGE. Yes.

Senator STENNIS. All right.

Now, Hurricane "Donna" occurred soon after?

Mr. RUTLEDGE. Yes, sir.

Senator STENNIS. September 1960, was it not?

Mr. RUTLEDGE. Yes, sir.

Senator STENNIS. Isn't it true that the deterioration in the pin connections and the resulting motion of the tower, was caused by the wear and tear resulting from the motion of the sea? If not, what did cause it?

MOTION BECAME EXTREME

Mr. RUTLEDGE. Sir, in the report that we received initially, that Mr. Kuss testified to, which created considerable alarm, the report was a motion in the order of 1 inch. This was extremely alarming, because we could not understand what was causing this, that some new element had entered in.

We could not believe that the pins could wear this amount and on the basis of that information, we considered it an emergency situation, and that the above-water bracing should be installed on a crash program.

At the same time we requested these accurate measurements of the pins.

Senator STENNIS. Yes.

Mr. RUTLEDGE. The recorded measurements were three-eighths of an inch clearance, and we are not entirely sure whether this is entirely wear, or part of it existed in the original construction, because we do not have records of measurements from the original construction.

Senator STENNIS. Now, that is a new point, as I understand, that you raised, that this slackness of the pins which showed an obvious danger might have been due to faulty construction?

Mr. RUTLEDGE. I would not classify this as faulty construction. It might have existed in the constructed condition, sir.

Senator STENNIS. Well, if it had been constructed as you designed it, you would not have had that much motion, would you?

Mr. RUTLEDGE. That is right, sir.

Senator STENNIS. Therefore, it was either faulty construction or it was due to the wear and tear from the motion of the sea. It had to be one or the other?

Mr. RUTLEDGE. It was construction different than specified, or wear and tear; yes, sir.

Senator STENNIS. Now, as the designer and as one who is familiar with the subsequent difficulties, aren't you able to say definitely whether it was constructed properly?

POSSIBILITY THAT CONSTRUCTION MAY HAVE BEEN IMPROPER

Mr. RUTLEDGE. We had no part in or responsibility for construction supervision. Our contract required us to advise the officer in charge of construction at his request.

Senator STENNIS. Yes.

Mr. RUTLEDGE. And we didn't have any people looking to see whether the fabrication and the construction was in accordance with the plans and specifications.

Senator STENNIS. Well, I do not want to belabor this point, but it seems to me that it is a major one.

The only information I have about such matters arises from the fact that on one occasion I built a house, and the architect followed up on his blueprints and his designs to see that the house was properly constructed.

Mr. RUTLEDGE. We do that, sir, on, oh, perhaps half or three-quarters of the jobs that we do, primarily for private industry.

Senator STENNIS. Yes. Well, that is a very reasonable part of your obligation, if it is in the contract.

Now, why didn't you do it this time? It wasn't in the contract?

Mr. RUTLEDGE. Because the standard practice of the Bureau of Yards and Docks is to do construction supervision themselves. They have a very competent staff for this purpose.

Senator STENNIS. All right. So it wasn't in your contract, and you therefore had no responsibility at all to follow up on this and supervise the actual construction?

Mr. RUTLEDGE. Except for the two items I have testified to.

Senator STENNIS. Those excepted?

Mr. RUTLEDGE. Yes, sir.

Senator STENNIS. Now, you must have something rather concrete and tangible in your mind as a basis for saying that this construction might have been improper. Now, what was it, Dr. Rutledge?

Mr. RUTLEDGE. I have no specific information about this construction. I simply state this from experience in checking up other structures. We frequently find individual points or certain details that exceed the specification limits, because it is almost a physical impossibility for the people who are supervising construction to check absolutely every detail.

Senator STENNIS. You are familiar with this matter. It became a matter of concern to both you and Mr. Kuss, and attracted considerable attention before it fell and, of course, after it collapsed. I imagine you discussed this matter considerably. Based on any re-

ports that you had before or after it fell, what have you learned about this original construction being in accord with your specifications?

Mr. RUTLEDGE. I think the major thing that we have learned is that the sea conditions in an extreme storm or hurricane can be much greater than anyone thought they could be at the time of the original design.

Senator STENNIS. My question, though, was, Mr. Rutledge—maybe I didn't make it clear. What have you learned about whether or not the construction came up to your specifications? That is the question.

Mr. RUTLEDGE. The things we have learned specifically were that, first, the two braces were lost; that they had to be replaced; that in the replacement, the installation resulted in motion of the collars, which had to be corrected; that the upper minus 25—that the pin at the upper minus 25-foot level, that pin clearance in the holes was either larger or had increased to something larger than specified.

Does that answer the question, sir?

Senator STENNIS. Well, I think that is getting down to it. Based upon that information and your professional knowledge, do you think that probably the construction was not up to your specifications with reference to pin tolerances and related matters?

Mr. RUTLEDGE. As far as I know, sir, at the time Mr. Crockett examined this tower in, I believe it was, June 1959, everything was reported by him to be apparently within the design tolerances.

Senator STENNIS. I know, and I am not trying to get you to say anything. You are under oath. What I have asked is whether, based on your information, do you think the probabilities are, after all, that this construction did not come up to your specifications originally as to pin tolerances?

Mr. RUTLEDGE. With only those exceptions, sir, I think that the tower was constructed properly and in accordance with specifications, and that when these, I would class, rather small deficiencies were corrected by 1959, that it was, in fact, in accordance with the design.

Senator STENNIS. So, if the construction was all right so far as these pin connections are concerned, then the deterioration was the result of wear? Is that correct?

Mr. RUTLEDGE. That is a point we do not know definitely, but according to the evidence, if the evidence is correct, that would be true; that the increase from one-eighth to three-eighths would be wear.

Senator STENNIS. And is it your opinion that that is what caused it?

Mr. RUTLEDGE. My opinion, sir, would be that we don't know definitely; that it could be wear or could be small changes in the original. In fact, there is no way of knowing.

I might mention, of course, that these pins are designed with quite low stresses in anticipation of some wear.

Senator STENNIS. Well, we are about back where we started now with reference to the two alternatives. But, of course, the other testimony, Mr. Rutledge, as to the deterioration in the pin connections, shows a greater figure than you think is the correct figure as to the increase in tolerances.

Mr. RUTLEDGE. I believe, sir, that the figures contained in our report and shown by the photographs were very carefully taken and from what we can see of the figures, they look reliable.

Senator STENNIS. Well, based upon your information, is that what you would call ordinary wear and tear for those pins?

Mr. RUTLEDGE. It seems larger than ordinary wear, yes, sir.

Senator STENNIS. All right.

Now, just a few more questions here. If the X-braces increased the net strength, and that is your opinion, I am sure, you said so and I believe you are telling the truth as you see it, why were they not included in the original design?

Mr. RUTLEDGE. They were an emergency measure, sir, because the report immediately prior to their design and installation was an unusual and alarming condition of the pins at minus 25 feet. These were a means of correcting an existing structure, which we felt had the potential of being in a dangerous condition. We would not consider the above-water bracing a sound or economical solution for an original structure, but we were faced with what we felt might be an emergency situation.

Senator STENNIS. And that situation was the loss of the braces below the water, as well as the increase in pin tolerance?

Mr. RUTLEDGE. No, sir. At that time, there was no loss of braces below the water. There was the reported looseness of the pins at elevation minus 25 feet. The braces were still there and intact.

Senator STENNIS. So the X-braces were put in just to meet the situation resulting from the looseness of the pins?

CORRECTION OF OBJECTIONABLE MOTION

Mr. RUTLEDGE. And to correct or to improve the motion condition that the personnel had found objectionable.

Senator STENNIS. Well, that motion condition was due primarily to the looseness of the pins, wasn't it?

Mr. RUTLEDGE. I don't believe so, sir. The motion was part of the fact that this structure is almost 300 feet above the ocean bottom and it sways, as any building or structure sways due to the elastic deformation of the members.

Senator STENNIS. And it was swaying more than you expected it to when you designed it. Is that right?

Mr. RUTLEDGE. We analysed for the sway under design conditions and design stresses and our computations anticipated a sway of plus and minus 4 inches under design conditions, a total of 8-inch horizontal motion.

Senator STENNIS. Now, you refer to the personnel and to the objections or the uncertainty engendered in their minds. You are talking about the men that occupied the tower?

Mr. RUTLEDGE. The Air Force people, yes, sir.

Senator STENNIS. Did that situation exist over several years, so far as you know?

Mr. RUTLEDGE. We were informed that the tower had swayed from approximately the time of original construction and Mr. Brewer's measurements were measurements of the character of the sway.

Senator STENNIS. Now, I have another matter here. I think you have covered this, but I was reading the contractor's testimony last night or yesterday and also the Navy's. In substance, the contractor said that the Navy made the decision to attempt repairs at sea rather

than take the tower back to port. The contractor said he approved the Navy's decision.

The Navy said the contractor made the decision, but that they approved the contractor's decision. Now, what part did you have in that decision?

Mr. RUTLEDGE. Sir, I was on the supply ship, the Steers-M-K in Fall River at this time, or coming out of Fall River with Mr. Steers to get to the site. I had no part in the decision to which you refer.

Senator STENNIS. Did any of the members of your firm have any part in that decision?

Mr. RUTLEDGE. Not to my knowledge, sir.

BRACES TORN LOOSE DURING TOW AND UPENDING

Senator STENNIS. Now, perhaps everybody has understood except me, but is it true that the braces which were broken in upending were torn entirely loose from the rest of the framework?

Mr. RUTLEDGE. Sir, my understanding is, and this is hearsay, that during the tow prior to the upending one of the braces was torn loose and actually came away from the structure and that during the upending process, the other brace was observed to break free of the structure.

Senator STENNIS. Two braces broke free of the structure?

Mr. RUTLEDGE. Yes, sir.

Senator STENNIS. Before it was actually upended and put in place.

Mr. RUTLEDGE. That is what I have understood, sir.

Senator STENNIS. That is what I understood, but I wanted to cover it because there seemed to be a little confusion.

LOOSE PIN CONNECTIONS

Now, Mr. Kuss, may I refer back to your letter of April 1, 1960. It seems to me that it is very pertinent. In refreshing your recollection, one paragraph reads as follows:

> The loose pin connections are a very serious matter since there seems to be no way of satisfactorily remedying this condition. Furthermore, the condition is one which will tend to worsen at an increasing rate with time. This is because the looseness induces impact stresses in the pins and pin plates which are greater than for the nondynamic design assumptions and will become increasingly greater as the play in the joint enlarges.

Now, that just sounds like a whole lot of commonsense packed into a very few words to me. I know you thought that was correct when you wrote it and you still think so, is that right?

Mr. KUSS. Yes, sir.

Senator STENNIS. Now, as I understand it, as to these pin connections which were loose, there was no satisfactory way of getting at that and remedying the condition itself.

Mr. KUSS. We had not been able to devise any.

Senator STENNIS. Yes.

Mr. KUSS. I attended a meeting at the Stewart Air Force Base to discuss this thing. They had their engineers present and I had one of mine and we spent the whole day trying to figure some way to fix those pins. We still hadn't given up. We found no way at that time, but we still hadn't given up.

Senator STENNIS. Yes.

Mr. KUSS. As I mentioned before, I believe, we felt that possibly, if we got these above-water braces in, then we could go down and take out the old pins and at least put in a larger one. But you could not do that until the above-water braces were in.

Senator STENNIS. So that is when you installed the X-braces above the water. You never were able to do anything about the loose pins, were you?

Mr. KUSS. No, sir, you see, we were able to examine the loose pins more carefully and we were still talking about them, but winter was coming and we couldn't have done anything before the next year, anyway.

Senator STENNIS. Let me repeat this last sentence again:

> This is because the looseness induces impact stresses in the pins and pin plates which are greater than for the nondynamic design assumptions.

That means that it is greater than the design assumptions that were cranked into the design; is that right?

Mr. KUSS. Yes, sir; I think that is another one of the practical statements.

Senator STENNIS. Beg pardon?

Mr. KUSS. I think that is another one of the practical parts of the letter. Here is a member that is floating loosely in a hole and there is bound to be some impact.

Senator STENNIS. It is so plain and well worded that I was afraid I didn't understand it, not being an engineer. However, it seems to me that you made it exceedingly clear. Your commonsense prediction there was that the looseness would become increasingly greater as the play enlarged.

Do you have anything further?

All right, Counsel.

POSSIBILITY OF CONSTRUCTION DEFICIENCY

Mr. KENDALL. Mr. Rutledge, I believe you suggested the possibility that the looseness in the pins could have resulted from a contractor deficiency; is that right? The possibility?

Mr. RUTLEDGE. I would hesitate to call that a contractor deficiency. I would say it would not be unusual if a one-eighth-inch tolerance was specified and three-sixteenths of an inch actually did occur at one or two locations.

Mr. KENDALL. I believe the first underwater inspection was made in the fall of 1958?

Mr. RUTLEDGE. Yes, sir; I believe this was in September 1958.

Mr. KENDALL. And that revealed no slackness in the pin connections?

Mr. RUTLEDGE. That is right, sir.

Mr. KENDALL. If it had been the fault of the contractor, would not the slackness have been revealed at that time?

Mr. RUTLEDGE. Sir, this is a very difficult measurement to make, and in order to make it the keeper plates would have to be removed. These are the plates that hold the pins in position. To my knowledge, the keeper plates were not removed at that time.

Mr. KENDALL. But it would be true that if the inspection was properly made, that it could not be a contractor deficiency or fault?

Mr. RUTLEDGE. If it were an accurate and complete careful examination; that is correct.

Mr. KENDALL. That is all I have, Mr. Chairman.

Senator STENNIS. Mr. Rutledge, is there any further point, in view of the question that you have been asked, that you wish to make?

Or you, Mr. Kuss? You may confer with counsel if you wish, briefly.

Mr. SHAW. Mr. Chairman?

Senator STENNIS. Yes.

Mr. SHAW. I have no doubt that counsel for the committee and the men that investigated this matter prior to these hearings checked into this matter. I have not heard any questions asked with reference to two documents—three documents—that I think are quite significant as bearing on the slippage in the pin, as bearing on estimates in percentages of the tower.

I would refer the committee to a document, a letter, dated September 18, 1958, from Mr. Kuss to the Officer in Charge of Construction, having to do with the first diver inspection of Mr. Crockett.

I would refer the committee to a communication from the Officer in Charge of Construction to the Air Force installation representative, office, New England region, Boston, Mass., apparently dated October 8, 1958. And I would refer, in that connection, to a further communication which appears to be an interfile memorandum attached to this letter reporting on an Officer in Charge of Construction conference of October 1, 1958, on stability of Texas tower No. 4.

Senator STENNIS. Who are the letters from, Counsel?

Mr. SHAW. I thought I had indicated that.

Senator STENNIS. I think you did but I didn't hear.

Mr. SHAW. The letter I referred to was from Mr. Kuss to the Officer in Charge of Construction. The other was from the Officer in Charge of Construction to the Air Force.

Mr. KENDALL. Mr. Chairman, I do not know whether those are in the record already, but we certainly have no objection to their being made a part of the record at this time.

Mr. SHAW. I am quite sure they are not in the record and that is the reason I raised the question.

Senator STENNIS. Very good. We will be glad to insert them in the record at this time as an exhibit to Mr. Rutledge's testimony and Mr. Kuss'.

(The documents referred to are as follows:)

SEPTEMBER 18, 1958.

Re: Stability of Texas tower No. 4.

OFFICER IN CHARGE OF CONSTRUCTION,
Texas Towers NOy Contracts,
Navy Building, Boston, Mass.

DEAR SIR: We were informed yesterday afternoon by Mr. Eugene Rau, of the firm of Steers & Morrison-Knudsen, contractors on the subject tower, that the diver employed by the Navy for inspecting this structure had found that the collar connecting the replacement brace to the "A" leg in the upper panel of the bracing was loose, that some or all of the 1-inch sheer bolts were missing, and that the collar had a movement of approximately 1 inch up and down on the leg cylinder. This indicates, of course, that the brace is ineffective and furthermore the opposite brace in the same panel and connecting to the "B" leg is also

useless since the bracing is of the "K" type, and the stresses in the two inner connecting diagonals are equal. This is a serious condition.

In July we made a study of the strength of the tower if such a condition should exist. The results of this study were reported to you by letter of July 3, 1958, and indicated that with an allowed increase in stresses up to the yield point, the tower would stand moderately heavy weather. At that time we had no real reason to believe that the braces were not working, and since the stormy season was still some time off, we made no great issue of the subject except to recommend in our report that a diver be employed to inspect the bolted collars and that a program be inaugurated to measure tower deflections. As things stand now the diver inspection has been made with a resulting discouraging report, and also the beginning of the hurricane season has come. We are concerned that the tower cannot safely withstand a major hurricane with the braces in the present loose condition. We recommend that every possible effort be made to tighten the bolts connecting the two halves of the collars holding the two replacement braces.

If possible the tightening of each bolt should be to a torque of 1,300 foot-pounds using a winch to pull the wrench. The collars should be tightened to a point where they do not move with respect to the legs, even if some bolts are broken and have to be replaced in the process. Only then can the problem of restoring shear bolts or connections be met.

In the meantime, and if the collars cannot be tightened and the shear bolts replaced, we are compelled to warn you that a definite hazard exists to the safety of the tower and the personnel aboard in the event of a major hurricane passing directly over the tower location.

Very truly yours,

MORAN, PROCTOR, MUESER & RUTLEDGE.
THEODORE M. KUSS.

OCTOBER 8, 1958.

From: Officer in Charge of Construction, Texas tower.
To: Air Force Installations Representatives Office, New England Region, Boston, Mass.
Subject: Stability of Texas tower No. 4.
Encl: (1) Report of OICC conference of October 1, 1958, same subject.

1. This letter confirms information reported to Commander, 4604th Support Squadron on September 24, 1958, regarding the stability of Texas tower No. 4, and reports subsequent developments from that date to October 3, 1958.

2. The governing criteria (max.) for the design of the tower was as follows:
Wind velocity: 125 miles per hour.
Wave height: 35-foot breaking or 60-foot nonbreaking.
Resulting allowable stress: (1/SC +50 percent, not to exceed 29,000 pounds per square inch.

3. After reports from the using activity that the tower seemed to move to a greater degree than the previous towers, the A. & E. was requested to compute the conditions under which the tower could be considered safe presuming that the upper bay of bracing in the A–B plane is inoperative. The results of this study are tabulated below:

(*a*) 125 miles per hour wind plus 36-foot wave nonbreaking, or

(*b*) 87 miles per hour wind plus 67-foot wave nonbreaking, with maximum resulting stress 30,000 pounds per square inch.

4. A recent inspection disclosed the following discrepancies:

(*a*) The pin connecting the top strut to the B leg was partially retracted, although it appeared to be in full bearing against the fish plates. An emergency stop has been applied to this pin to prohibit further movement until equipment to make permanent repairs can be obtained.

(b) The collar which connects the K brace to the A leg at elevation 65 was not tight around the leg. The 2-inch bolts did not exhibit the required torque, and the Dardelet bolts were sheared off. In effect, while these conditions prevail, this particular bracing panel is not functioning, and the modified stability conditions given in paragraph 3, (*a*) and (*b*), above would apply.

5. During the inspection the 2-inch bolts were tightened to the designed torque. Hence, at present, the tower is safe for greater wind and wave conditions than those quoted, but until the Dardelet bolts are replaced, will not reach the original design condition.

6. Special replacement bolts are now being fabricated, and will be installed as soon as available, consistent with weather conditions.

7. A copy of the notes taken at a conference held on October 1 is furnished herewith as enclosure (1). A copy of the inspection report will be forwarded when received.

T. J. WHITE, *Acting.*

Memorandum.
From: 110.
To: Files.
Via: 100.
Subject: OICC conference of October 1, 1958, on the stability of Texas tower No. 4, report of.

1. A conference was held on Wednesday, October 1, 1958, in the office of the officer in charge of construction to discuss the stability of Texas tower No. 4. The following personnel were in attendance:

Mr. Ted Kuss representing Moran, Proctor, Mueser & Rutledge, the A. & E.

Messrs. Gene Rau and Robert Koch of prime contractor, Steers, Morrison-Knudsen.

Mr. David Crockett, representative of Marine Contractors, the diving contractor.

Captain Stark, Lieutenant Matheson, Warrant Officer Hardy, Air Force of Otis Air Force Base.

Comdr. E. R. Foster and Joseph G. A. Riccio.

Mr. J. F. Donegan of Lincoln Laboratory.

2. The Marine Contractors representative reported the latest situation.

3. The A. & E. representative stated that if the top guy of bracing in the A–B plane was not operative, he felt a hurricane could cause serious damage and possible loss of the tower. He further stated that, in his opinion, with this bracing inoperative, the tower could withstand 87 miles per hour winds accompanied by 67-foot nonbreaking waves. Captain Stark stated that the tower had already sustained 87 miles per hour winds with 55-foot waves for a 9-hour period.

4. It was concluded by the parties present, that the repair of the leak, which was discovered during the inspection, should be deferred if it required disturbing or moving of the bracing in any manner which would adversely affect the structural integrity of the tower.

5. It was agreed that the Dardelet bolts which sheared in the collars, be replaced with high-tensile steel T bolts. It is estimated that 3 weeks will be required for delivery of the T bolts, and approximately 2 weeks diving weather to install them. The installation should be completed by November 15, 1958, weather permitting. Mr. Kuss mentioned that additional bracing of the template on the AB side only, and baffles in the oil tanks are being considered under the modification program, the feasibility study for which is now being prepared.

Mr. SHAW. Could I also say this, that I appreciate the courtesy of the committee in handling my clients.

Senator STENNIS. We are delighted to have you here, sir. We think you have served the country and the committee.

Mr. Kuss, do you have any further point you wish to make in view of the questions that have been asked you?

Mr. KUSS. I think not.

Senator STENNIS. All right.

Now, the Chair again announces that as far as is now known, this will conclude the testimony in this hearing, unless the Navy or the Air Force wishes to present further testimony. It is again announced that we shall be glad to hear further from them if they wish. I do ask, however, that they notify the counsel or the director of the staff immediately if they wish to be heard further.

All right, if there is nothing further, I thank you, gentlemen, very much. Your most fine attitude in coming here should be commended. I think you have helped the cause, as I say. The committee will have a report on this matter as soon as it reasonably can.

We are confronted with an amazing series of events, gentlemen. The design, fabrication, construction and upending of the tower represented a difficult and far-reaching undertaking and task. It was no child's play to construct the tower, to tow it from port, to erect it or to operate it. It was all most demanding. But it is an amazing series of events to me that from the time it was upended until it collapsed, years later, there was never a time, except for a short interval as I view the testimony, during which the tower even nearly approached its intended and its original design strength. This is not the time to assess blame. The committee is not trying to assess blame at this time. We are interested, as we announced in the beginning, in the strength of our military program, and our defense program, for which the Air Force and Navy deserve a great deal of credit. We are interested in following up the dollars that we in Congress take away from people to pay for this program and other Government programs. We want to strengthen the military and the armed services, not weaken them. We want to protect the individuals involved, contractors, professional men and all where protection is justified. I think this hearing has been timely in another way, if I may say so. It appears to me that the full development of these facts up to January 12, 1961, by the legislative branch of the Government, affords a proper and a necessary background against which any man in the military who may have charges preferred against him may be tried properly. Without the facts developed here, I don't see how it would have been possible, unless the military went through an inquiry similar to ours, to have gotten all the background facts and information in their true perspective.

Now, I repeat that the committee has endeavored to refrain from inquiring into the facts in the case which occurred after January 12, 1961, which was 3 days before the tower fell. Those facts will be a major part of the matters in dispute in any court-martial proceedings that may be held, if they are held.

Now, the chairman has not said a single word throughout all these hearings about the 28 men in the service and out of the service who lost their lives in this tragic occurrence. I have refrained from doing that, not because of lack of concern, interest or appreciation for the sacrifice that they made, and not because of lack of sympathy for their relatives and loved ones, but merely in an effort to keep this committee out of any inquiry except the hard facts involved in the design, construction, repair, and operation of the tower. But I thought that before closing we certainly ought to express our great regret and respect as well as the utmost appreciation of the committee, the Congress, and the country for the service of these 28 men and the sacrifice that they made for their country. I think that they deserve the same recognition, the same credit, as do those persons who died in actual combat, in time of actual war, and in battle. It certainly was a battle station to which these men were assigned and we bow in appreciation of their service and respect to their memory. They were patriots in every sense of the word.

All right, with the thanks of the committee again, gentlemen, to all, the committee will now take a recess subject to the call of the Chair.

(Whereupon, at 12:45 p.m., the subcommittee recessed subject to the call of the Chair.)

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We are confronted with an amazing series of events [illegible]. The design, fabrication, construction, and operation of the tower [illegible] a difficult and far-reaching undertaking and [illegible]. It was no child's play to construct the tower, to tow it from port, to erect it [illegible] temporarily. It was all most demanding. But it is an amazing series of events to see that from the time it was installed until it collapsed, years later, there was never a time, except for a short interval as I view the testimony, during which the tower ever nearly approached its intended and its original design strength. This is not the time to assess blame. The committee is not trying to assess blame at this time. We are interested; we are concerned at the beginning, in the strength of our military programs, and our defense programs, for which the Air Force and Navy deserve a great deal of credit. We are interested in following up the dollars that we in Congress take away from people to pay for this program and other Government programs. We want to strengthen the military and the armed services, not weaken them. We want to protect the individuals involved, contractors, professional men and all, where protection is justified. I think this hearing has been timely in another way, if I may say so. It appears to me that the full development of these facts up to January 15, 1961, by the legislative branch of the Government, affords a proper and a necessary background against which any man in the military who may have charges preferred against him may be tried properly. Without the facts developed here, I don't see how it would have been possible, unless the military went through an inquiry similar to ours, to have gotten all the facts, [illegible] and information in their true perspective.

Now, I repeat that the committee has endeavored to refrain from inquiring into the facts of the case which occurred after January 15, 1961, which was 2 days before the tower fell. Those facts will be a major part of the matters in dispute [illegible] court-martial proceedings [illegible], if they are held.

Now, the chairman has not said a single word throughout all these hearings about the 28 men in the service and out of the service who lost their lives in this tragic occurrence. I have refrained from doing that, not because of lack of concern, interest or appreciation for the sacrifice that they made, and not because of lack of sympathy for their relatives and loved ones, but instead in an effort to keep the committee and its inquiry around the hard facts involved in the design, construction, repair, and operation of the tower. But I thought that before closing we certainly ought to express our great regard and respect as well as the utmost appreciation of the committee, the Congress, and the country for the service of these 28 men and the sacrifice that they made for their country. I think that they deserve the same recognition, the same credit, as do those persons who fight in actual combat, in time of actual war, and in battle. It was a hazardous battle station to which these men were assigned and we bow in appreciation of their service and respect to their memory. They were patriots in every sense of the word.

All right, with the thanks of the committee again, gentlemen, to all, the committee will now take a recess subject to the call of the Chair.

(Whereupon, at [illegible] p.m., the subcommittee recessed subject to the call of the Chair.)